2022 Building Performance Analysis Conference and SimBuild

September 14th - September 16th, 2022

Wednesday, September 14

Wednesday, September 14, 8:10 AM - 9:00 AM

Keynote

Donnel Baird

Donnel Baird is the founder of BlocPower, a climate tech startup based in Brooklyn. BlocPowers tech platform analyzes, finances, and installs clean energy and building decarbonization upgrades in buildings in underserved communities. BlocPower creates jobs for qualified local low-income workers, energy savings for building owners, reduces carbon emissions and asthma rates, and provides financial returns to investors. In 2021, the company announced a historic partnership with Ithaca, New York to decarbonize 100% of the city's buildings—the first such project in the United States. Baird is a graduate of Duke University and Columbia Business School.

Wednesday, September 14, 9:10 AM - 10:10 AM

Paper Session 1 (Intermediate)

Daylighting

This session introduces recent advances in daylighting analysis and design technologies. First, we consider a novel computational workflow to customize illuminance ranges and select target areas to examine local light levels in residential applications. Then, we explore the ability of vectorized computer languages to increase the speed of annual daylighting calculations. Finally, we show how parametric iterative algorithms can be used to design prismatic skylights that optimize useful daylight, glare reduction, and energy consumption.

1. Speeding up Annual Daylighting Simulation Using NumPy

Nathaniel L Jones, Ph.D., Associate Member*, Arup, Boston, MA*

2. Energy and Daylight Simulation Analysis of an Innovative Horizontal Skylight System Incorporating a Bi-directional Scattering Distribution Function (BSDF) Prismatic Optical Layer
Mohammad Salamati[1], *Wayne Place*[1], *Curtis Fentress*[2] *and Masoome Haghani*[1], *(1)North Carolina State University, Raleigh, NC, (2)Fentress Architects, Denver, CO*

3. Using Illuminance Ranges and Target Areas to Analyze Daylight in Multi-Dwelling Units
Guanzhou Ji *and Azadeh O. Sawyer, Carnegie Mellon University, Pittsburgh, PA*

9:10 AM - 10:10 AM

Seminar 1 (Basic)

An Effective Solution for Climate Change Adaptation, IAQ and Energy Considerations

This session will be an interactive exploration of climate change, carbon removal, energy use, and indoor air quality in the built environment. Through a participatory framework using a software tool to help facilitate conversation, we will simulate a methodology for assessing risks in the built environment, identifying pain points of building owners and occupants, and developing a novel solution for the identified energy, indoor air quality, and climate adaptation challenges. A technical background will be provided at the start of the session and then a series of questions will be asked to guide participants through the simulated product development experience.

1. An Effective Solution for Climate Change Adaptation, IAQ, and Energy Considerations
Jo Norris, Member[1] *and* ***Nancy McClellan, MPH, CIH, CHMM, Member***[2], *(1)Carbon Reform, Newark, DE, (2)American Industrial Hygiene Association, Falls Church, VA*

9:10 AM - 10:10 AM

Seminar 2 (Intermediate)

Modeling Existing Buildings

Modelling of existing buildings presents unique challenges which can differ quite substantially from one building to the next depending on many technical and non-technical factors. This session covers two tools for assessing existing buildings as well as one unique case study of a historic museum. The first tool discussed is focused on retrofitting opportunities for small to medium commercial buildings while the second is focused on rapid modelling for ESG assessments. The museum case study presents the use of specialized simulation techniques to solve the specific challenges facing the museum.

1. Frozen Paintings, Interior Gutters: Simulating a 1960s Museum
Graham Linn, P.E.*, HabLab, Madison, WI*

2. A Simple Building Calculator (SBC) for Evaluating Commercial Building Performances
Weili Xu, Ph.D., Associate Member[1], *Chitra Nambiar, Associate Member*[2] *and Reid Hart, P.E., Life Member*[3], *(1)PNNL, United States of America, Seattle, WA, (2)PNNL, United States of America, (3)PNNL, United States of America, Richland, WA*

3. Energy Modeling for Green Property Conditioning Assessment
Krishnan Gowri, Ph.D., BEMP, Fellow ASHRAE*, Intertek Building Science Solutions, Bothell, WA*

9:10 AM - 10:10 AM

Seminar 3 (Intermediate)

Occupant Health, Well-being and Comfort

This session presents three studies that use advanced simulation and analysis techniques to assess the impacts of the built environment on human occupants. The first presentation investigates the variation of temperature across time and across space in single family residences and its impact on thermal comfort. This is followed by a study of the impact of thermal conditions on sleep for older occupants. The final presentation considers the impact on occupant behavior patterns of simulated building performance metrics.

1. Validation of Spatiotemporal Thermal Comfort Variation in Single-Family Residential Buildings
Maharshi Pathak, Student Member*, Emily Casavant, Student Member, David Fannon and Michael Kane, Ph.D., Member, Northeastern University, United States of America, Boston, MA*

2. The Impact of Bedroom Thermal Environment on Sleep in Community-Dwelling Older Adults
Amir Baniassadi, Ph.D.[1], *Wanting Yu*[2], *Ryan Day*[2], *Angel Wong*[2], *Thomas Travison, Ph.D.*[1], *Lewis Lipsitz, M.D.*[1] *and Brad Manor, Ph.D.*[1], *(1)Harvard Medical School, Boston, MA, (2)Marcus Institute for Aging Research, Boston, MA*

3. The Potential of Building Simulation Integrated into Behavioral Experiments
JeeEun Lee, Student Member *and Ying Hua, Ph.D., Cornell University, Ithaca, NY*

Wednesday, September 14, 10:30 AM - 12:00 PM

Paper Session 2 (Intermediate)

Approaches to Modeling Future Weather, Climate and Extreme Events I

This session discusses the role future weather, climate and other extreme climate events play in decisions concerning the nexus between energy efficiency, resiliency, and load flexibility. The first presentation discusses optimization approaches for building envelope to account for future climatic demands. The next presentation discusses the development of a simplified battery storage sizing tool to estimate storage needs for homes operating off-grid. The session discusses the importance of a stochastic model of future weather conditions, so that dynamics between resilience metrics and efficiency metrics can be fairly assessed. The final presentation evaluates the passive survivability under extreme weather events.

1. Multi-scenario Extreme Weather Simulator Application to Heat Waves
Villa, Daniel L. Villa[1]*, Juan Pablo Carvallo, Ph.D.*[2]*, Carlo Bianchi*[3] *and Sang Hoon Lee, Ph.D.*[4]*, (1)Sandia National Laboratories, (2)Lawrence Berkeley National Laboratory, Berkeley, CA, (3)National Renewable Energy Laboratory, Golden, CO, (4)Lawrence Berkeley National Laboratory, United States of America*

2. Building Envelope Optimization for Future Climatic Demands by Simple-Box Model Energy Simulation
Mitra Azimi *and Juan Carlos Baltazar, Texas A&M University, College Station, TX*

3. Evaluation of the Thermal Resilience of a Community Hub
Aylin Ozkan, Ph.D.[1] *and Joel Good, P.Eng.*[2]*, (1)RWDI, Toronto, ON, Canada, (2)RWDI, Vancouver, BC, Canada*

4. Development of a Battery Capacity Sizing Tool for Optimal Sizing of Residential-Scale Backup and Microgrid Energy Systems
Kate Bren*, Maya Hazarika and Charles Upshaw, Positive Energy*

10:30 AM - 12:00 PM

Paper Session 3 (Intermediate)

CFD Applications for Architectural Decision Making

This session introduces some of the recent CFD applications, ranging from thermal comfort, health, to emergency management. First, speakers evaluate the thermal performance and thermal comfort provided by newly design thermally active student's desk. Speakers also discuss the health-related applications, including using CFD to assess the COVID spread in a grocery store as well as discuss how to combine CFD with machine learning to accelerate the simulation of particulate modeling around buildings. Lastly, speakers explain how to use CFD to assist the safe evacuation analysis and means of egress layout for emergencies.

1. Numerical Investigation of Thermal Comfort of Thermally Active Students Desk (TASD) in a Historical Building
Lobna Mitkees[1]*, Mohammad Heidarinejad, Ph.D., P.E., Associate Member*[1] *and Brent Stephens, Associate Member*[2]*, (1)Illinois Institute of Technology, Chicago, IL, (2)Illinois Institute of Technology, Chicago, IL, USA*

2. A Computational Fluid Dynamics Model for the Assessment of Sars-cov-2 Aerosol Dispersion Inside A Grocery Store
Mingkan Zhang, Ph.D., Member[1]*, Prateek Shrestha*[1]*, Xiaobing Liu, Ph.D., Member*[1]*, Jason DeGraw, Ph.D., Member*[1]*, Dustin Schafer, P.E.*[2] *and Nathan Love*[2]*, (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)Henderson Engineers, Lenexa, KS*

3. Towards Healthy Built Environments: A Hybrid CFD and Machine Learning Approach for Modeling Airflow and Particulate Matters Around Buildings
Mehdi Ashayeri[1] *and Narjes Abbasabadi*[2]*, (1)Southern Illlinois University, Carbondale, IL, (2)University of Texas, Arlington, TX*

4. Using CFD Model to Assist Safe Evacuation Analysis and Means of Egress Layout Evaluation in Adaptive Re-use
Chen, Xiaolei Chen*, California State University*

10:30 AM - 12:00 PM

Seminar 4 (Intermediate)

Modeling Advances: Tools and Workflows I

This session starts with discussing a new tool that assists designers by integrating commercial building energy surveys, recent ASHRAE research, and comparative analysis of historical vs. future weather data. This session also covers the predictability of future occupant presence based on collected occupancy sensor data, as well as the impact of tangential costs (repairing damaged interior finishes as part of a fenestration replacement project, e.g.) on results of Life-Cycle Cost Analysis (LCCA). The session concludes with a discussion of balancing simulation precision and detail with efficiency and profit margins via benchmarking, simplified analysis, and isolated test models.

1. Rapid Energy Design Tool: Research-Grade Energy and Climate Data for Energy-Conscious Design
Amir Rezaei-Bazkiaei, Ph.D., BEMP, Associate Member[1] *and Brett Horin*[2]*, (1)CannonDesign, BUffalo, NY, (2)CannonDesign, Chicago, IL*

2. Predictability Analysis of Occupant Presence in Residential Buildings
Sunghyun Kim *and Cheol-Soo Park, Ph.D., Department of Architecture and Architectural Engineering, Seoul National University, Seoul, Korea, Republic of (South)*

3. Building Enclosure Life-Cycle Cost Analysis: Examples of Bias and the Skewing of Results
Cheryl Saldanha, P.E.[1] *and* ***Abigail Sefah***[2]*, (1)Simpson Gumpertz & Heger, New York, NY, (2)Simpson Gumpertz & Heger, Boston, MA*

4. Level of Detail Question in Building Simulations
Emir Pekdemir, BEMP, Associate Member*, WSP USA, New York, NY*

10:30 AM - 12:00 PM

Seminar 5 (Intermediate)

Open Source Modeling for District Energy Systems

This seminar introduces recent efforts in developing open source modeling tools for district energy systems based on URBANopt and Modelica Buildings library, which is a joint effort of NREL, LBNL and Penn State. We will introduce new Modelica models for steam-based district heating system and future low carbon systems. Then we will discuss the integration of URBANopt and Modelica. We will also demonstrate the usage of such tool with some real-world examples.

1. A Fast and Accurate Modeling Approach for Water and Steam Thermodynamics with Practical Applications in District Heating System Simulation
Wangda Zuo, Ph.D., Member*, Pennsylvania State University, State College, PA*

2. Design of Decarbonized District Energy Systems with the Modelica Buildings Library
Michael Wetter, Ph.D., Member*, Lawrence Berkeley National Laboratory, Berkeley, CA*

3. Rapid Development of District Models Using Urbanopt District Energy System
Nicholas Long, P.E., Member*, National Renewable Energy Laboratory, United States of America, Golden, CO*

Wednesday, September 14, 1:40 PM - 3:10 PM

Paper Session 4 (Intermediate)

Innovations in Passive and Hybrid Heating and Cooling I

Authors in this session discuss several strategies evaluated for the City of Chicago to reduce residential heating loads, natural ventilation as a passive technology and shows two data-driven advanced control designs for natural ventilation, integrating algae photobioreactors into facades, to act as a passive HVAC system, and recover the heat generated by the system for space heating. Also presented are façade-integrated photovoltaics and an evaluation of different configurations which can impact the efficiency of the system as well as an innovative wall component integrating the flexible PV panels with the wall insulation system.

1. Sun and Stone in the Windy City: New Evidence for Direct Solar Heating Performance in Greater Chicago
Alexandra R. Rempel, Ph.D. *and Alan Rempel, University of Oregon, Eugene, OR*

2. Performance of Energy Activated ETICS Applied in the Urban Environment of Street Canyons
Dominika Knera*, Dariusz Heim and Anna Wieprzkowicz, Lodz University of Technology, Poland*

3. Direct Integration of Flexible Photovoltaic with the Wall: A Simulation Approach to Determine Panel Performance
Dariusz Heim*, Anna Wieprzkowicz and Dominika Knera, Lodz University of Technology, Poland*

4. Winter Natural Ventilation Control With Operable Windows: Application Of Statistical Simulation In The Transformation From Predictive Control To Reinforcement Learning Control
Wei Zhang *and Ali Malkawi, Harvard Center for Green Buildings and Cities, Cambridge, MA*

1:40 PM - 3:10 PM

Paper Session 5 (Intermediate)

Modeling Advances and Validation of Modeling Results

This session covers various topics related to large-scale residential building analysis and validation of modeling results using empirical data. The first speaker covers a large-scale simulation methodology which evaluated the impact of trade-offs on building envelope performance. The second presentation introduces a methodology for using empirical data for residential buildings to validate predicated energy use results. Next, a random forest machine learning model to predict envelope assembly characteristics for existing buildings is presented. The final presentation evaluates the effects of a new daylighting system on the thermal and electric load of a typical office building.

1. Energy Performance Comparison of Venetian Blind and a New Daylighting System: Combined System of Reversible, Energy Conservative Window-Shading

Masoome Haghani[1], *Behrouz Mohammad Kari*[2] *and Rima Fayaz*[3], *(1)NCSU, (2)Building and Housing Research Center (BHRC), Tehran, Iran, (3)Department of Architecture, Art University of Tehran, Iran*

2. Predicting Building Envelope Construction from In-Situ Thermal Testing
Tyler James Pilet[1] *and Tarek Rakha*[2], *(1)Pacific Northwest National Laboratory, (2)Georgia Institute of Technology, Atlanta, GA*

3. Large Scale Simulation to Investigate the Residential Envelope Trade-offs for High-Efficiency Equipment and Renewables Based on 2021 IECC
Yulong Xie, Ph.D.[1], *Victor Salcido*[1], *Yan Chen, Ph.D.*[2], *Todd Taylor*[2], *Benjamin Taube*[2] *and Michael Rosenberg, Fellow ASHRAE*[2], *(1)Pacific Northwest National Laboratory, Richland, WA, (2)Pacific Northwest National Laboratory, Portland, OR*

4. Coupled Model of Heat and Power Flow in Unventilated PV/PCM Wall-Initial Validation of the En-ActivETICS
Anna Wieprzkowicz*, Dominika Knera and Dariusz Heim, Lodz University of Technology, Poland*

5. Improving Residential Building Simulations Through Large-Scale Empirical Validation
Benjamin Park*, Scott Horowitz, Noel Merket and Dave Roberts, NREL*

1:40 PM - 3:10 PM

Seminar 6 (Intermediate)

Intelligent Building Operations: Efficiencies and Load Management I

How can we best choreograph the many moving parts of building systems for greatest efficiency or effectiveness? This session explores new integrations of coordinated space heating systems, the optimization of fire prevention systems, and the development and application of an extensive new end use load profile database.

1. Integrated Control of Radiant Floor Heating Systems in Residential Buildings
Seongkwon Cho[1], *Jin-Hong Kim*[1] *and Cheol-Soo Park, Ph.D.*[2], *(1)Seoul National University, Seoul, Korea, Republic of (South), (2)Department of Architecture and Architectural Engineering, Seoul National University, Seoul, Korea, Republic of (South)*

2. End Use Load Profiles
Eric Wilson, Andrew Parker, Anthony Fontanini and ***Matthew Dahlhausen, Ph.D., Associate Member****, National Renewable Energy Laboratory, Golden, CO*

3. COVID-19 Impacts on Residential Energy Usage from the Northwest End Use Load Research Project
Jessica N. Keast*, Resource Refocus, Berkeley, CA*

4. Bayesian Network-Based Probabilistic Approach for Optimal Placement of Fire Detectors for Fire Safety Performance-Based Design
Jung Ah Lee *and Sean Hay Kim, Ph.D., Seoul National University of Science and Technology, Seoul Metropolitan City, Korea, Republic of (South)*

1:40 PM - 3:10 PM

Seminar 7 (Advanced)

Optimizing Buildings for Zero Carbon Lifetime Operations: Part 2

This session is a follow-up to our 2021 ASHRAE BPAC session: 30-yr GHG Forecasts Using Marginal and Average Emissions, where we sought to optimize office building design for minimal operational carbon by employing strategies including electrification, onsite renewables, and battery storage. This session will focus on analyzing multifamily buildings' lifetime emissions using NREL's hourly Cambium data and design optimization using the same intervention strategies. We will discuss updates to the Cambium data, which now includes upstream methane, and the impact on the previous results. We will also analyze the mechanical systems' refrigerants and their Scope 1 emissions.

1. Optimizing Office Buildings for Zero Carbon Lifetime Operations (a review)
Jamy Bacchus, P.E., BEMP, Member*, ME Engineers, Denver, CO*

2. Optimizing Multifamily Buildings for Zero Carbon Lifetime Operations
Caitlin Anderson, P.E., Member*, ME Engineers, Denver, CO*

3. Analyzing Refrigerant Scope 1 Emissions for Lifetime Operations
Sedighehsadat Mirianhosseinabadi, Ph.D., Associate Member*, ME Engineers, Golden, CO*

Wednesday, September 14, 3:30 PM - 5:00 PM

Paper Session 6 (Intermediate)

Urban and Community Scale Modeling

Urban scale and building stock simulations present the challenge of representing many buildings through a much smaller number of models. First, authors share how building type can be inferred from utility-provided energy use data. Then, they evaluate how

well common data-driven black-box models work for regulatory calculations to support policy making. Next, speakers identify comparable variables in urban scale models that correlate inputs with results. Using Manhattan as a case study, we share a framework for renewable energy-based urban planning. Finally, the authors examine how optimal control of battery sizes can promote equity in energy access.

1. Optimal Sizing of Integrated Community Energy Systems Considering Equity Constraints
Christoph Gehbauer[1]*, Yulun Wu*[2]*, James Brown*[1] *and Michael Sohn, Ph.D.*[1]*, (1)Lawrence Berkeley National Laboratory, Berkeley, CA, (2)University of California, Berkeley, CA*

2. Derivation of Comparative Variables for Energy Model Calibration using Data-driven Method
HyeGi Kim *and Sun Sook Kim, Ph.D., Member, Ajou University, Suwon, Korea, Republic of (South)*

3. Using Measured Building Energy Data to Infer Building Type For Urban Building Energy Modeling
Brett Bass[1]*, Evan Ezell*[2] *and Joshua New, Ph.D., Member*[3]*, (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)University of Tennessee, TN, (3)Oak Ridge National Laboratory, Knoxville, TN*

4. Infomophism: An Urban Planning Framework for Local Renewable Energy Integration
Fengqi Li*, Kristen Schell, Haolin Yang and Alexandros Tsamis, Rensselaer Polytechnic Institute*

5. Data-Driven Machine Learning Model Performance of Real Annual Natural Gas Consumption in Residential Buildings
Matthias Y.C. Van Hove*, Ghent University, Belgium*

3:30 PM - 5:00 PM

Paper Session 7 (Intermediate)

Building Operation, Performance and Controls

Building performance depends on not only how the building is designed but also how the building is operated. In this regard, it is important to improve building operational performance by optimal controls, automatic fault detection and diagnosis, and machine learning. The first three papers cover input data uncertainty, sensor faults and the use of collected data for optimal building controls. The fourth paper investigates the dual fuel heat pump controls for energy and cost savings in residential buildings. Finally, the 5th paper presents the optimal demand response control for heat pump water heaters.

1. Development of Demand Response Control Schedules of Heat Pump Water Heaters for California Residential Code Compliance
Aaron Boranian, BEMP, Associate Member[1]*, Ben Larson*[2] *and Bruce A. Wilcox, P.E., Member*[3]*, (1)Big Ladder Software, Denver, CO, (2)Larson Energy Research, Menomonie, WI, (3)Bruce A. Wilcox, Berkeley, CA*

2. Evaluating the Impacts of Weather Forecast Inaccuracy on Performance of Model Predictive Control for Dynamic Facades
Peter Grant *and Christoph Gehbauer, Lawrence Berkeley National Laboratory, Berkeley, CA*

3. Incipient Sensor Fault Impacts on Building Performance through HVAC Controls
Yanfei Li, Ph.D., Associate Member*, Yeobeom Yoon and Piljae Im, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN*

4. Potential Heating Energy and Cost Savings of Dual Fuel Heat Pump Control as a Retrofitting Method for Residential Buildings in the U.S.
Yeobeom Yoon[1]*, Yanfei Li, Ph.D.*[1]*, Piljae Im, Ph.D., Member*[1] *and James Lyons*[2]*, (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)Newport Partners LLC, Davidson, MD*

5. Evaluating the Performance of Chiller Plant Efficiency Using Random Forest Model: A High-Rise Building Case Study
Behzad Salimian Rizi, Student Member[1]*, Mohammad Heidarinejad, Ph.D., P.E., Associate Member*[1]*, Greg Pavlak, Ph.D., Member*[2] *and Vincent Cushing*[3]*, (1)Illinois Institute of Technology, Chicago, IL, (2)Penn Sate University, State College, PA, (3)QCoefficient, Inc., Chicago, IL*

3:30 PM - 5:00 PM

Seminar 8 (Advanced)

Building Envelope Performance and Design Considerations for Mechanical Engineers

High-performance buildings require mechanical systems that reduce energy consumption while maintaining indoor air quality. To achieve this, mechanical engineers must understand the role of building envelopes towards overall building performance . This seminar will define key design considerations of high-performance building envelope systems and address common missteps regarding building envelope performance values for energy models. . Specifically, we will review fenestration and

spandrel U-factor calculations, envelope thermal bridges and thermal comfort, mechanical system impact on surface condensation, and review envelope air leakage assumptions. The seminar includes case studies to provide practical examples of each topic.

1. Condensation Considerations for Mechanical Engineers
***Corey C. Wowk, AIA**, Simpson Gumpertz & Heger, New York, NY*

2. Thermal Bridge Considerations for Mechanical Engineers
***Cheryl Saldanha, P.E.**, Simpson Gumpertz & Heger, New York, NY*

3. U-Value Considerations for Mechanical Engineers
***Leonidia M. Garbis, P.E.**, Simpson Gumpertz & Heger, New York, NY*

4. Air Leakage Considerations for Mechanical Engineers
***Ali Yalaz, P.E.**, Simpson Gumpertz & Heger, New York, NY*

3:30 PM - 5:00 PM
Seminar 9 (Intermediate)

Unique Topics

This session covers several topics including CFD for grow houses, inequities in building energy use, lighting for demand response, and strategies for balancing IAQ and energy consumption. The first presentation introduces an approach using CFD to optimize grow house designs for plant growth. The second is a review of recent research on inequities in building energy use and guidance for how professionals can drive change. The third outlines the potential for using lighting as a distributed energy resource via demand response signals. The fourth is an evaluation of different contaminant removal strategies balancing indoor air quality and energy consumption.

1. Utilizing CFD to Optimize Grow House Building Designs
***Chaitanya Johar, P.E., Associate Member**, AAON, Inc, Tulsa, OK*

2. What the Energy Modeling Community Can Do to Minimize Inequalities in Building Energy Usage
***Bryce Cox, P.E., BEMP, Member**, University of Wisconsin Platteville, Platteville, WI*

3. How Can Demand Curves be Used to Configure Connected Lighting Systems to Respond to Openadr Signals?
***Shat Pratoomratana** and Michael Poplawski, Associate Member, Pacific Northwest National Laboratory, Portland, OR*

4. Evaluating Ventilation Strategies to Balance the Indoor Quality Needs and Energy Consumption
***Wangda Zuo, Ph.D., Member**, Pennsylvania State University, State College, PA*

Thursday, September 15

Thursday, September 15, 8:10 AM - 9:00 AM
Keynote

Luke Leung

Luke is a LEED Fellow; a member of ASHRAE COVID19 task force; AIA Task Force on COVID-19; Chair of "Environmental Health Committee"; Member, Expert Peer Review Committee for Council on Tall Buildings and Urban Habitat; Former Board of Directors for USGBC, Illinois; Former Chairman of ASHRAE Technical Committee on "Tall Buildings"; ASHRAE Distinguished Lecturer; Industrial Professional Advisory Council Pennsylvania State University Architectural Engineering School; Industry Advisory Board for IN2 start-up incubator program with National Renewable Energy Laboratory. He is the wide firm Director of the Sustainability Engineering Studio for Skidmore, Owings and Merrill LLP.

Thursday, September 15, 9:10 AM - 10:10 AM
Debate (Intermediate)

It's Time to Revise the Standard Thermal Comfort Zone of ASHRAE Standard 55

With summer comes air-conditioning, and for many, that means packing an extra sweater to keep the goosebumps at bay. Winter can be equally challenging, as people in cold climates swelter in offices warmed to a toasty 72F. Is it possible that the ASHRAE 55 standard comfort zone is due for an update? The urgency of addressing climate change, the high energy consumption of space heating and cooling and the limited research base supporting the standard comfort zone suggest that, perhaps, it could be. In this debate, we'll hear experts in the field debate the resolution.

9:10 AM - 10:10 AM

Paper Session 8 (Intermediate)

Building Envelope Design, Daylighting and Energy Performance

This session includes three papers which cover diverse but highly interesting topic. This session starts off with a presentation which explores visual comfort and daylight performance of an office building through metrics including sDA and ASE. The next presentation in this session evaluates how algae bio-reactive building envelopes can regulate a building's natural lighting and demonstrates the significance of self-adaptive shading to a building's heat gain and energy savings. The final presentation in this session introduces climate adaptive opaque building envelopes (CABEs) which dynamically exchange heat between indoor and outdoor environments to reduce energy demands for heating and cooling.

1. Algae Bio-reactive Building Envelope: Dynamic Lighting and Energy Aspects for Algae-based Building Skin
Jingshi Zhang[1], *Alexandros Tsamis*[2] *and Daniel Rosenberg*[3], *(1)The Pennsylvania State University, (2)Rensselaer Polytechnic Institute, (3)Carnegie Mellon University, Pittsburgh, PA*

2. Simulation Analysis as a Tool to Obtain Indoor Environmental Quality and Energy Efficiency in Tropical Climate Buildings at an Early Stage Design
Larissa Azevedo Luiz*, Caroline Viana de Souza, Pedro Caio Rossi and RaquelSan Sanches, Ca2 Consultores, Brazil*

3. Modeling, Simulation, and Evaluation of a Double-Sided Hydronic Layer Embedded Opaque Climate-Adaptive Building Envelope
Youngjin Hwang[1], *Amogh Wasti*[1], *Theodorian Borca-Tasciuc*[1], *Justin Scott Shultz, Ph.D., Associate Member*[2] *and Luigi Vanfretti*[1], *(1)Rensselaer Polytechnic Institute, (2)EYP Architecture & Engineering, Washington, DC*

9:10 AM - 10:10 AM

Seminar 10 (Intermediate)

Approaches to Modeling Future Weather, Climate and Extreme Events II

This session covers approaches to modeling future weather, climate, and extreme events. The first topic outlines data, analytics, and evaluation methodologies to identify populations that are especially vulnerable to extreme heat events, and possible mitigation strategies in both the long term and short term. The next topic visualizes and explore the nuances of different weather files, discuss their use in typical applications, and provide guidance on common mistakes. The final presentation explores a case study on solar heat gain coefficients to align building design with future energy generation, optimizing for both total and "net" annual electric demand.

1. Urban Thermal Diagnostics and Extreme Heat Vulnerability in Underrepresented Communities
Hala Alfalih*, WSP, Chicago, IL*

2. Right Weather for the Right Modelling Application: What, How and Where?
Nishesh Jain, Ph.D., Member*, University College London / DesignBuilder Software, London, United Kingdom*

3. Aligning Building Design with Future Energy Generation: Case Study of Solar Heat Gain Coefficients
Holly Samuelson, AIA, Member[1] *and Amir Baniassadi, Ph.D.*[2], *(1)Harvard Graduate School of Design, Cambridge, MA, (2)Harvard Medical School, Boston, MA*

9:10 AM - 10:10 AM

Seminar 11 (Intermediate)

Modeling Advances: Tools and Workflows II

This session introduces modelling advances related to climate data, u-value calculations, and empirical validation of Building Performance Simulation (BPS) programs. The first presentation presents a detailed comparison of climate data derived from 5 ground stations and satellite data including simulation results for a prototype commercial office building. The second presentation presents a method for quantifying the discrepancy between measured and catalog-based U-value calculations. The third presentation focuses on the development and steady-state application of a test facility designed for empirical validation of thermal fabric models that seeks to help bring empirical validation to standard software evaluation procedures.

1. Contrasting Ground Station Vs Satellite Climate Data Impacts on Building Simulation
Drury Crawley, Ph.D., BEMP, Fellow Life Member[1] *and Linda Lawrie, Member*[2], *(1)Bentley Systems, Inc., Washington, DC, (2)DHL Consulting LLC, Pagosa Springs, CO*

2. Filling the Gap: Measured Composite Envelope U-Values and How We Usually Calculate Them
Jeannie Kim, Ph.D., BEMP, Member[1], *Joel Neymark, P.E., Member*[2] *and Ralph Muehleisen, Ph.D., P.E., Member*[1], *(1)Argonne National Laboratory, Lemont, IL, (2)J. Neymark & Associates, Golden, CO*

3. Empirical Validation with ETNA Data: In the Beginning ....
Joel Neymark, P.E., Member*, J. Neymark & Associates, Golden, CO*

Thursday, September 15, 10:30 AM - 12:00 PM

Panel (Basic)

Embodied Carbon of MEP Systems

This panel will be a discussion on the embodied carbon of MEP systems. The panel includes industry experts from mechanical design firms that have worked on studies for projects on understanding the impact of MEP embodied carbon and refrigerants. The panel will also include a leader in the MEP 2040 Challenge, an initiative started by the Carbon Leadership Forum that sets commitments for firms to lower the embodied carbon of MEP systems. The panel will also include a member of the City of Chicago's decarbonization task force, discussing future policy decisions that can help lower a building's whole life carbon.

1. Embodied Carbon of MEP Systems 1
***Luke Leung, P.E., BEMP, Member**, Skidmore, Owings, & Merrill LPP, Chicago, IL*

2. Embodied Carbon of MEP Systems 2
***Kathleen Hetrick**, BuroHappold*

3. Embodied Carbon of MEP Systems 3
***Drew Nitschke**, Glumac*

10:30 AM - 12:00 PM

Paper Session 9 (Intermediate)

Lifecycle Carbon Assessment

Understanding the carbon footprint of buildings is essential to reducing carbon emissions and combating climate change. This session details new techniques for quantifying embodied carbon and presents two case studies that examine the embodied carbon of building materials.

1. Operational Carbon Emission Methodology Literature Review
***Nathan Vader**, Atelier Ten*

2. A Decarbonization Proforma of Modular Building Solutions
***Noah Benjamin Conrad Klammer**[1], Ankur Podder[1], Kaufman Zoe[2] and Shanti D. Pless, Member[3], (1)Affiliated Engineers, Inc., (2)National Renewable Energy Lab, Golden, CO, (3)National Renewable Energy Laboratory, Golden, CO*

3. Realistic Estimation of CO2 Emission Reductions Due to Building Retrofit
***Yingli Lou**[1], Yunyang Ye, Ph.D., Associate Member[2], Wangda Zuo, Ph.D., Member[3] and Yizhi Yang[1], (1)University of Colorado, Boulder, (2)Pacific Northwest National Laboratory, PORTLAND, OR, (3)Colorado University at Boulder, Boulder, CO*

4. Locking in Carbon Reduction: A Life Cycle Assessment Case Study
***Yogitha Miriyala**[1], Amanda Thounaojam[1], Prasad Vaidya[1] and Sanjay Prakash[2], (1)Indian Institute for Human Settlements, Bangalore, India, (2)Studio for Habitat Futures, New Delhi, India*

5. Heuristic Urban-Scale Life Cycle Assessment of Districts to Determine their Carbon Footprints
***Schildt, Maximilian Schildt**[1], Johannes Linus Cuypers[1], Avichal Malhotra[1], Maxim Shamovich[1], Jérôme Frisch[1] and Christoph van Treeck, Ph.D.[2], (1)Institute of Energy Efficiency and Sustainable Building (E3D), RWTH Aachen University, Germany, Germany, (2)RWTH Aachen University, Aachen, Germany*

10:30 AM - 12:00 PM

Paper Session 10 (Intermediate)

Advances in Modeling Tools, Approaches and Workflows

This session introduces developments and innovation in modeling tools and workflows. The first presentation discusses the development of occupancy schedules for school buildings. The second presentation introduces a python-based tool for pre-simulation validation of space boundaries and a semi-automatic process for correction of errors. The next speaker discusses a new set of tests for ASHRAE Standard 140. This is followed by a presentation on the development of a new VRF heat pump. Finally, we talk about the HVAC control modeling tools and control sequence implementations based on ASHRAE RP 1711.

1. Development of an Occupancy Schedule for OpenStudio Prototype College Building Model
***Yeonjin Bae, Ph.D., Associate Member**, Yeobeom Yoon, Sungkyun Jung, Ph.D., Mini Malhotra, Ph.D. and Piljae Im, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN*

2. Comparison of a Variable Refrigerant Flow Heat Pump Model in Cooling Mode to Data from ASHRAE HQ
***Aziz Mbaye, Member**[1] and Massimo Cimmino, Ph.D., P.E.[2], (1)Polytechnique Montréal, Montréal, QC, Canada, (2)École Polytechnique de Montréal, Montréal, QC, Canada*

3. Data Center Chiller Plant: Simulation-based Comparative Control Design Case Study
Grahovac, Milica Grahovac[1], *Paul Ehrlich, P.E.*[2], *Jianjun Hu*[1] *and Michael Wetter, Ph.D., Member*[1], *(1)Lawrence Berkeley National Laboratory, Berkeley, CA, (2)Building Intelligence Group, Afton, MN*

4. ASHRAE Standard 140 Weather Drivers Test Suite: Results Analysis
McDowell, Timothy P McDowell[1] *and Ralph Muehleisen, Ph.D., P.E., Member*[2], *(1)Thermal Energy System Specialists, LLC, (2)Argonne National Laboratory, Lemont, IL*

5. Validation of IFC-based Geometric Input for Building Energy Performance Simulation
Richter, Veronika Richter[1], *Avichal Malhotra*[2], *Eric Fichter*[1], *Anna Hochberger*[1], *Jérôme Frisch*[2] *and Christoph van Treeck, Ph.D.*[3], *(1)RWTH Aachen University, Institute of Energy Efficiency and Sustainable Building (E3D), Germany, (2)Institute of Energy Efficiency and Sustainable Building (E3D), RWTH Aachen University, Germany, Germany, (3)RWTH Aachen University, Aachen, Germany*

10:30 AM - 12:00 PM

Seminar 12 (Intermediate)

Intelligent Building Operations: Efficiencies and Load Management II

This session starts with using measured data from a radiant floor heating system to optimally control such a system via Model Predictive Control (MPC). This session also covers an overview of the End Use Load Profiles project that culminated in a publicly available dataset of calibrated residential and commercial end-use schedules, as well as analysis of residential energy use trends in pre-pandemic vs. pandemic data. This session concludes with a novel study using a Bayesian network-based probabilistic approach to determine fire detector placement that minimizes detection time and detector quantity in a three-story office building in Korea.

1. A Progress Report on Ashrae Standard 205P
Charles Barnaby, Fellow Life Member*, CSB Consulting, Moultonborough, NH*

2. Emission Reduction Retrofit Strategies with Fuel Switching Using Air-to-Water Heat Pump Central Plant Systems
Christopher DesRoches, P.Eng., Member[1] *and Krishnan Gowri, Ph.D., BEMP, Fellow ASHRAE*[2], *(1)Mitsubishi Electric Sales Canada Inc., Markham, ON, Canada, (2)Intertek Building Science Solutions, Bothell, WA*

3. A New Paradigm for Automatically Verifying Control Performance in Building Energy Model
Jeremy Lerond, Affiliate[1], ***Yan Chen, Ph.D.***[2], *Xuechen Lei, Ph.D., Associate Member*[1] *and Yun Joon Jung*[2], *(1)Pacific Northwest National Laboratory, Richland, WA, (2)Pacific Northwest National Laboratory, Portland, OR*

4. Using Semantic Models for Enhanced Building Analytics Application
Parastoo Delgoshaei*, National Institute of Standards and Technology (NIST), Gaithersburg, MD, USA*

Thursday, September 15, 2:30 PM - 3:30 PM

Panel (Basic)

Fishbowl Session

This session will be an informal, informative discussion among peers regarding modeling and modeling-related issues that affect us in a major way. The Fishbowl helps facilitate discussion by having 3-4 people in the center of the room, talk at any one time on the specified topic. Audience members are invited to participate by selecting a panelist to replace when they have a question or comment. Topics of discussion include:

- *What are your biggest challenges? (Not only techniques, but processes, training, etc.)*
- *How do you manage multiple projects?*
- *How are your models used, and how can they become more useful?*

Friday, September 16

Friday, September 16, 8:10 AM - 9:00 AM

Keynote

Amber Mahone

Amber Mahone leads E3's Clean Energy practice area, which specializes in analyzing and modeling longterm greenhouse gas reduction strategies in the energy economy, including a focus on building electrification and future of natural gas questions. She

has led California's analysis of greenhouse gas reduction strategies and worked on similar projects focusing on the Northwest, New York, New England, and the entire U.S. Ms. Mahone's expertise ranges from renewable integration, to transportation and building efficiency and electrification, to biofuels and emerging low-carbon technologies. Ms. Mahone holds an M.P.A. from Princeton University and a B.A. in International Relations from Wellesley College.

Friday, September 16, 9:10 AM - 10:10 AM

Paper Session 11 (Intermediate)

Building Simulation Education and Quality Assurance

This session includes three papers with different but very interesting and important topics. The first paper talks about the integration of building performance simulation into the existing curricula of architectural education. The second paper presents an automated approach to help modelers quality check building energy models at the early design phase. The third paper is an empirical study that compares a passive house to a conventional one in Manhattan, New York, bases on indoor environmental quality and energy consumption.

1. An Automated Approach for Quality Checking Early Design Phase Building Energy Models
***Brett Andrew Horin**, CannonDesign*

2. One Step at a Time: Why Confidence, Familiarity, and Trust are Key to Building Performance Simulation in Architectural Education
***Jonathan Yorke Bean** and Laura Carr, The University of Arizona*

3. I Lived in a Passive House Building: Here's What I Learned
***Shemesh, Sigal Shemesh**, Buro Happold*

9:10 AM - 10:10 AM

Seminar 13 (Intermediate)

Evolving Performance Indicators

This session begins with a summary report of the energy use and effectiveness of several combinations of germicidal UV with HVAC systems in mitigating SARS-Cov-2. Assumptions from previous studies are discussed and future research suggested. The second presentation addresses the limitations of EUI (energy use intensity) as a performance indicator and provides suggestions for an alternative metric derived through analysis involving 800 simulations of various building configurations. This is followed by a proposal to consider additional, non-tradition metrics when engaged in the design and planning of cities—with a focus on the reduction of negative environmental impacts.

1. Comparing the Energy Use and Effectiveness of Upper Room Germicidal Ultraviolet Radiation and HVAC Strategies to Combat Sars-Cov-2
***Belal Abboushi**, Pacific Northwest National Laboratory, Portland, OR*

2. Normalization of Building Energy Use Under Different Locations and Occupant Densities
***Young-Seo Yoo**[1], Dong-Hyuk Yi, Ph.D.[2], Deuk-Woo Kim, Ph.D.[3] and Cheol-Soo Park, Ph.D.[1], (1)Department of Architecture and Architectural Engineering, Seoul National University, Seoul, Korea, Republic of (South), (2)System & Energy Division in Korea Testing Laboratory, Korea, Republic of (South), (3)Department of Building Energy Research in Korea Institute of Civil Engineering and Building Technology, Korea, Republic of (South)*

3. Performance Analytics of Net Zero City
***Sukreet Singh, BEMP**, Cuningham, Las Vegas, NV*

9:10 AM - 10:10 AM

Seminar 14 (Intermediate)

Innovations in Passive and Hybrid Heating and Cooling II

Wind, sunlight, solar heat, cool night air, and cold night skies are the renewable energy sources featured in this session, highlighting their potential to free the renewably-powered grid for uses that require electricity. Capturing and using these climatic resources to their greatest advantage through intelligent controls and optimizations is a rapidly evolving field, explored here in high desert, subtropical, Mediterranean, and cold continental climates.

1. Design of Murbs in a Hot and Dry Climate through Integrative Environmental Analysis
***Haobo Liu**[1] and **Saurabh Shrestha**[2], (1)DIALOG Design, Vancouver, BC, Canada, (2)DIALOG Design, Toronto, ON, Canada*

2. Outdoor Educational Spaces: Generative Shading Design for a Warming Climate
***Mili Kyropoulou**, University of Houston, Houston, TX*

3. Hybrid Cooling with Operable Electrochromic Windows
***Ranojoy Dutta, BEMP and HBDP, Associate Member**, 1529, SAN JOSE, CA*

Friday, September 16, 10:30 AM - 12:00 PM

Paper Session 12 (Intermediate)

Simulation Calibration and Validation

Building simulation plays an important role in making informed decisions on building retrofits. When applying simulation models for existing buildings, the models need to be calibrated and validated against real operation data. This session discusses OpenStudio model calibration for a cross laminated timer building. The session also covers the EnergyPlus model validation for the Net-Zero Energy Residential Test Facility at NIST. The third paper investigates the use of a calibrated building model to certify a net positive energy building during the pandemic. The final paper presents a decision-support framework to maximize the retrofit impact for government-owned public buildings.

1. Empirical Validation of Whole Building Energy Simulation Program under Free-Floating Conditions
Hyojin Kim, Ph.D., Member[1]*, Elizabeth Scacifero*[1]*, Minkyeong Park*[1]*, Piljae Im, Ph.D., Member*[2]*, Lisa Chen Ng, Ph.D.*[3]*, Brian Dougherty, P.Eng.*[3] *and William V. (Vance) Payne, Ph.D., Member*[3]*, (1)New Jersey Institute of Technology, Newark, NJ, (2)Oak Ridge National Laboratory, Oak Ridge, TN, (3)National Institute of Standards and Technology, Gaithersburg, MD*

2. Operating and Certifying a Net Positive Energy Building During a Pandemic
Jung-Ho Lewe*, Georgia Institute of Technology*

3. Highly Instrumented Cross Laminated Timber Building: Sub-metering from Panels to Desks
Gabriel Flechas, Student Member*, Paulo Cesar Tabares-Velasco, Ph.D., Associate Member and Gabe Fierro, Ph.D., Colorado School of Mines, Golden, CO*

1. Decision Support Framework for the Retrofit of Public Buildings for Energy and Carbon Reduction
Baliga, Rashmi Baliga[1] *and David Conant-Gilles*[2]*, (1) Affiliated Engineers, Inc, (2) Affiliated Engineers, Inc.*

10:30 AM - 12:00 PM

Seminar 15 (Intermediate)

An Overview of Simplified Energy Modeling Approaches and Tools: Industry Applications

Simplified Building Energy Modeling (S-BEM) is an approach to building energy simulation that aims to make energy modeling easier, faster, and more accessible to designers. Although most often used to inform early-stage design decisions, S-BEM is a powerful performance analysis tool that is gaining traction in industry and has the potential to provide an alternative to prescriptive options for incentive programs and code compliance. This session will discuss the motivation behind the development of a simplified modeling ruleset, the Simplified Performance Rating Method, as well as two S-BEM tools that are actively in use today.

1. Lessons Learned from a Decade of Simplified Modeling
Chris Baker, AIA, BEAP and BEMP*, Willdan*

2. Simplified Performance Rating Method: Testing and Validation Results
Andrea Mengual, P.E.*, Pacific Northwest National Laboratory, Seattle, WA*

3. Sketchbox and Its Applicability in Industry
Ben Heymer, P.E., Member*, Slipstream*

10:30 AM - 12:00 PM

Seminar 16 (Intermediate)

Modeling Advances: Tools and Workflows III

The use of parametric modelling to support building design is becoming more frequent across many disciplines including energy analytics. In this session, two presentations outline uses of parametric modelling: one for early design stage analytics including a case study of a manufacturing facility and another for large parametric studies using prototype models. Additionally, this session includes the presentation of a tool for assessing re-tuning measures in buildings using an EnergyPlus validated modelling procedure. Finally, this session also includes a presentation on the development of energy modelling guidelines specifically tailored to higher education buildings.

1. Standardizing Low Energy Buildings in Higher Education
Ethan Heil, P.E., Member*, University of Virginia, Charlottesville, VA*

2. Modelkit Flannel Edition: Workflow Automation and Prototype Models for Large Parametric Studies
Peter Ellis, Member*, Big Ladder Software, Denver, CO*

3. Providing Energy Modelling Tools for Building Owners to Inform Early-Stage Building Design
Annie Marston, Ph.D. *and Finlay Milliner, Hydrock Consultants, Bristol, United Kingdom*

4. Introducing the Building Re-Tuning Simulator
Nick Fernandez, Associate Member*, Pacific Northwest National Laboratory, Richland, WA*

10:30 AM - 12:00 PM

Seminar 17 (Intermediate)

Modeling for Carbon and Embodied Energy

As jurisdictions continue to put into place fines and other financial incentives to decarbonize the built environment, the calculation of operational and embodied carbon is gaining increased attention among a variety of stakeholders. This session includes four presentations covering early-stage modelling for decarbonizing central plants, real time carbon tracking for a university seeking to meets its target of becoming carbon neutral by 2030, and the use of Cambium in estimating operational carbon during the design process. The fourth presentation covers the use of ice storage to shifting heat pump electrical load based on grid capacity and carbon emissions.

1. Tale of Two Central Plants: Energy Efficiency and Carbon Emission Calculations Informed By "Lite Modeling"
Amir Rezaei-Bazkiaei, Ph.D., BEMP, Associate Member[1] *and Colin Hale*[2]*, (1)CannonDesign, BUffalo, NY, (2)CannonDesign, St Louis, MS*

2. Carbon Cents - a Clemson University & Rmf Partnership to Provide Carbon Use Tracking and Real Time Systems Adjustment to Reduce Energy
Miles Martschink Jr., P.E., Member[1] *and* ***Tim Howard***[2]*, (1)RMF Engineering, Clemson, SC, (2)Clemson University, Clemson, SC*

3. Ice Heating
Brian McKinney, BEMP, Associate Member*, Jaros Baum & Bolles, New York, NY*

4. Estimating Operational Carbon in Building Designs
Chris Savage, AIA, Associate Member*, LMN Architects, Seattle, WA*