



January 20th - January 24th, 2024

Saturday, January 20

Saturday, January 20, 3:15 PM - 5:00 PM
Special Session (Basic)

Plenary

Room: Grand Horizon DEFG

Join 2023-2024 ASHRAE President, Ginger Scoggins, for a Society update. Jeff Littleton, ASHRAE's Executive Vice President, will provide the Secretary's Report and Society Honors and Awards recipients will be recognized.

The keynote speaker will be Chris Turner, a well-known figure in Canada for his expertise on climate change solutions and the global shift towards clean energy. Based on his extensive research and reporting on renewable energy, cleantech, and urban design, Chris provides a compelling vision of a sustainable future.

Sunday, January 21

Sunday, January 21, 8:00 AM - 9:00 AM
Panel 1 (Intermediate)

Are Variable Refrigerant Flow Systems Viable in an A2L World?

Track: HVAC&R Systems and Equipment

Room: Great Lakes B

Sponsor: 8.7 Variable Refrigerant Flow (VRF)

Chair: Scott D McGinnis, Full Member, DIRECT EXPANSION SOLUTIONS, TX

This panel will educate on the viability of future VRF systems that use A2L refrigerants and discuss the upcoming move to A2L refrigerants and how the recent inclusion of A2L in ASHRAE 15, IMC and UMC will impact VRF equipment and system designs. Panel will discuss how these changes will ensure future VRF systems can be safely installed and operated. Panel will discuss how future VRF systems will be a necessary option to support the move towards increased energy efficiency and the decarbonization of our built environment.

Panelists:

1. **Badri Patel, BEAP, Full Member, Johnson Controls, Toronto, ON, Canada**
2. **Christopher W Williams, Full Member, Trane Technologies, TN**
3. **Scott P Hackel, PE, LEED AP, Full Member, Slipstream, Madison, WI**
4. **Madhav R Kashinath, Full Member, Daikin Comfort Technologies, Waller, TX**

8:00 AM - 9:00 AM

Paper Session 1

Accounting Embodied Carbon and Energy Conservation Measures for Building Decarbonization

Track: *Decarbonization and Climate Change*

Room: Great Lakes F

Chair: Ratnesh Tiwari, Full Member, University of Maryland, COLLEGE PARK, MD

To accomplish building decarbonization goals, it is essential to account for embodied carbon and carbon emissions from operational energy use. The first paper discusses life cycle assessment to study embodied carbon impacts of mechanical, electrical, and plumbing systems used for HVAC systems. The second paper presents several energy conservation measures to improve the performance of the building envelope and HVAC upgrades.

1. Embodied Carbon Impacts for Piping Distribution in Radiant and VAV Systems for an Office Building (CH-24-C001)

Matt Roberts, PhD, Affiliate¹, Fiona Greer¹ and Paul Raftery, PhD, Full Member², (1)UC Berkeley, Berkeley, CA, (2)Center for the Built Environment, UC Berkeley, Berkeley, CA

2. Existing Building Decarbonization Optimizing Cost and GHG Reduction (CH-24-C002)

Coral Winona Pais, P.E., BEMP, Full Member and Jason A Majerus, P.E., Associate, DLR Group, Cleveland, OH

8:00 AM - 9:00 AM

Paper Session 2

Simultaneously Increasing Indoor Air Quality and Decarbonizing Commercial Buildings

Track: *Decarbonization and Climate Change*



Room: Great Lakes G

Chair: Daniel L. Villa, PE, Full Member, Sandia National Laboratories, ALBUQUERQUE, NM

Traditionally, increasing indoor air quality is perceived to entail greater energy use. This session presents new technologies that can provide clean and healthy air and promote decarbonization.

1. The Paradox between Decarbonization and Indoor Air Quality and Using Technology to Solve the Dilemma (CH-24-C003)

Anthony M Abate, CIAQP, Full Member, Clean Air Group, Fairfield, CT

2. Decarbonizing Buildings with High-Performance Dedicated Outdoor Air Systems (CH-24-C004)

Colleen Collins, Associate¹, Bretnie Eschenbach, Full Member¹, Maria Murphy², Erdem Kokgil, Application Engineering Team Lead, Associate³ and Chris Wolgamott⁴, (1)Cadeo Group, Seattle, WA, (2)Northwest Energy Efficiency Alliance, (3)Oxygen8, Vancouver, BC, Canada, (4)Northwest Energy Efficiency Alliance, Portland, OR

3. Evaluating the Performance of a Solar Air Heating System for Preheating Building Ventilation Air (CH-24-C005)

Richard T Swierczyna, Full Member¹, Jason Stein, Engineer, Associate² and Jason J LaFleur, Full Member², (1)Gas Technology Institute, DAVIS, CA, United States, (2)GTI Energy, Des Plaines, IL

8:00 AM - 9:00 AM

Seminar 1 (Intermediate)

Driving Towards Decarbonization: Hydronics, the Perfect Transmission

Track: *Hydronic Systems*



Room: Great Lakes C

Sponsor: 6.1 Hydronic and Steam Equipment and Systems, 6.6 Service Water Heating Systems, 6.5 Radiant Heating and Cooling

Chair: Zachary J Londo, Associate, Uponor, Inc., APPLE VALLEY, MN

Low temperature heating and high temperature cooling are the keys to unlock the solutions for decarbonization. Hydronics is the perfect transmission to move thermal energy from heat pumps to radiant space heating and cooling and decentralized domestic water heating solutions.

1. Spread It Around: Large Surface Area Heat Exchangers Such As Radiant Systems Are the Uber Enablers of Low Temperature Heating, High Temperature Cooling

Robert Bean, Retired, Chestermere, AB, Canada

2. Platefuls of Domestic Water Heating: Generating Heated Potable Water Instantaneously – without Combustion

Stephanie Radel, CPD, GPD, CM-BIM, Associate, Uponor, Quispamsis, NB, Canada

3. Electrification Solutions for Existing High-Rise Buildings

Daniel H Nall, PE FAIA FASHRAE CPHC, BEMP and HBDP, Fellow Life Member, Daniel Nall, Consultant, LLC, Princeton, NJ

8:00 AM - 9:00 AM

Seminar 2 (Basic)

ESG: What is Social Responsibility?

Track: Fundamentals and Applications



Room: Water Tower A

Sponsor: 1.7 Business, Management & General Legal Education

Chair: Dunstan Laurence Macauley III, PE, Full Member, Setty and Associates, Rockville, MD

Are you eager to create an inclusive environment in your organization? What is social responsibility? What does Generation Z expect when looking at where they will work? We live and work in a diverse world. Whether you are a seasoned professional, a leader within your company, or working towards starting your career, this interactive workshop will provide a basic framework for a DEI plan, including what recent Gen Z graduates expect from their new employers. The short presentations will point you in the right direction, leaving plenty of time for interactive discussion.

1. Inclusive Work Environments

Jennifer E Leach, PE, Full Member, BR+A Consulting Engineers, WATERTOWN, MA, United States

2. Raising the Bar: Gen Z Expectations

Craig A Wanklyn, PE, Full Member, Kansas State University, MANHATTAN, KS

8:00 AM - 9:00 AM

Seminar 3 (Intermediate)

LIVESTREAM: Standards for Estimating Building Design Decarbonization Performance

Track: Decarbonization and Climate Change



Room: Great Lakes A

Sponsor: SSPC 90.2 & RBC

Chair: Philip W Fairey, Life Member, FSEC Energy Research Center, Cocoa, FL

Standards have been the primary tool for promoting improved energy performance of buildings for 50 years. Newly adopted and in process ANSI, ASHRAE, IECC and ISO standards are establishing metrics for greenhouse gas (GHG) performance based on hourly energy consumption, and some are establishing minimum levels of decarbonization performance. These standards provide a performance-based approach that incentivizes the reduction and potentially the net elimination GHG emissions. ASHRAE has established an aggressive position on building decarbonization and is rapidly expanding the technical guidance, standards and training that support building decarbonization. Standards harmonization is critical to the success of this endeavor.

1. Standards for Estimating Building Design Decarbonization Performance

Philip W Fairey, Life Member, FSEC Energy Research Center, Cocoa, FL

8:00 AM - 9:00 AM

Seminar 4 (Intermediate)

The Significance of Selecting the Right Project Delivery Method for Building Automation Projects: One Size Does Not Fit All!

Track: *Fundamentals and Applications*



Room: Great Lakes E

Sponsor: 1.4 Control Theory and Application, 7.5 Smart Building Systems

Chair: Frank Shadpour, Mechanical Engineer, ASHRAE Fellow, Fellow Member, SC Engineers, Inc., San Diego, CA

Choosing the right project delivery method is the pivotal first step that sets the course for a project's success. A one-size-fits-all approach does not apply, and the delivery method ideal for the entire project may not be the most suitable for each discipline. This seminar explores control system projects in different contexts, emphasizing the need to consider contract structure carefully. It introduces the "Design-Build Retro-Commissioning" approach and explores challenges in providing effective control systems for regulated entities like the Department of Defense. Valuable insights are offered on setting projects up for success by evaluating project delivery methods from the outset.

1. Considering Controls! Considerations for Selecting the Ideal Project Delivery Method in Building Automation System Upgrades.

Gregori John Tayco, EIT, Full Member, Grumman Butkus Associates, EVANSTON, IL

2. Are Master System Integrators the Answer? Determining the Ideal Contracting Structure for Control System Implementations

Maria G Campos, LEED AP, DCIE, Associate, Environmental Systems Design, Inc., Chicago, IL

3. Providing Effective Control Systems for Highly Regulated Entities While Implementing Cutting Edge Practices

Christopher Battisti, PE, Associate, US Army Corps of Engineers

8:00 AM - 9:00 AM

Workshop 1 (Intermediate)

Design Considerations and Challenges on Liquid Cooling Applications of Data Centers

Track: *Labs, Clean Spaces and Mission Critical Facilities*

Room: Water Tower B

Sponsor: 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

Chair: Timothy A Shedd, PhD, Fellow S-B-a Member, Dell Technologies, Lancaster, NY

The demand for high performance computing, machine learning, artificial intelligence and edge computing is driving an inflection point in the demand for higher power processor chips with lower temperature requirements. Simultaneously, data center cooling systems need to operate with higher efficiency to meet sustainability goals. These trends are accelerating the need for liquid cooling in the data center. This seminar focuses on the consultant's perspective - how to deploy liquid cooling applications both for new data centers and existing data centers.

1. Liquid Cooled Application to Retrofit in Existing Data Centers

John M Gross III, Full Member, J. M. Gross Engineering, LLC, Richmond, TX

2. New Design Consideration for Green-Field (New Data Centers)

John M Gross III, Full Member, J. M. Gross Engineering, LLC, Richmond, TX

Sunday, January 21, 9:45 AM - 10:45 AM

Panel 2 (Intermediate)

LIVESTREAM: Standard 241: You Have Questions; We Have Answers

Track: *Ventilation, Indoor Air Quality and Air Distribution Systems*

Room: Great Lakes A

Sponsor: SSPC241, EHC

Chair: Max Sherman, Ph.D., Fellow Life Member, ASHRAE, Moraga, CA

ASHRAE's own Operation *Warp Speed* was to develop and approve a new standard for the control of infectious aerosols in response to a White House request. Standard 241-2023 met that challenge and was approved at the Annual Meeting in June. Doing a standard in only four months has left many Members with questions about the standard. This session will answer audience questions with a panel made up of a few members of the standard's Executive Committee.

Panelists

1. William P Bahnfleth, Ph.D., P.E., Presidential Fellow Life SBA Member, The Pennsylvania State University, State College, PA
2. Chandra Sekhar, PhD, Fellow Member, National University of Singapore, Singapore, Singapore
3. Wade H Conlan, P.E., Member ASHRAE, BCxP, CxA, LEED®AP BD+C, BCxP, Full Member, Hanson Professional Services, Maitland, FL
4. Marwa Zaatari, PhD, Associate, D Zine Partners, Austin, TX
5. Stephen B Martin Jr, Ph.D., Member, CDC/NIOSH, Morgantown, WV
6. Meghan Kara McNulty, PE, Full Member, Servidyne, ATLANTA, GA

9:45 AM - 10:45 AM

Paper Session 3

Advancements in Thermal Energy Storage (TES): PCM-based TES, Market Barriers, and Optimizing Performance of TES Integrated Geothermal Heat Pump Systems

Track: *Fundamentals and Applications*



Room: Great Lakes F

Chair: Songhao Wu, Student, Purdue University, W LAFAYETTE, IN

This session explores sustainable building innovations, including PCM-based thermal energy storage (TES) integrated with building envelopes and HVAC systems. Survey-based insights highlight TES system's potential to contribute to the nation's grid stability and decarbonization goals and explores market barriers in TES applications. The presentation also explores integrating thermal energy storage with a geothermal heat pump system optimized through Model Predictive Control.

1. Experimental Investigation of a Novel PCM Based Fin-Tube Heat Exchanger System for Building Heating and Cooling Applications (CH-24-C006)

Achutha Tamraparni, Affiliate¹, Joseph D Rendall, Associate R&D Staff, Associate², Zhenglai Shen, R&D Associate Staff, Associate³, Diana Hun⁴, Som S Shrestha, Full Member³ and Hevar Palani, Student Member⁵, (1)Oak Ridge National Laboratory, (2)Oak Ridge National Lab, Oak Ridge, TN, (3)Oak Ridge National Laboratory, OAK RIDGE, TN, (4)Oak Ridge National Laboratory, Oak Ridge, TN, (5)University of Illinois, Chicago, IL

2. Survey-Based Interview Research to Assess Existing Barriers to TES Market Adoption for Heat Pump Applications (CH-24-C007)

Jyothis Anand Prem Anand Jayaprabha, Ph.D., Student¹, Xiaobing Liu, Ph.D., Full Member², Lingshi Wang, Ph.D.³ and Mini Malhotra, Ph.D.³, (1)Oak Ridge National Laboratory, OAK RIDGE, TN, (2)Oak Ridge National Lab, Oak Ridge, TN, (3)Oak Ridge National Laboratory, Oak Ridge, TN

3. Optimizing Performance of Thermal Energy Storage Integrated Geothermal Heat Pump Systems with Model Predictive Control: A Co-Simulation Study (CH-24-C008)

Liang Shi¹, Ming Qu, PhD, Full Member¹, Xiaobing Liu, Ph.D., Full Member², Borui Cui³, Jin DONG, ORNL, Associate³ and Lingshi Wang, Ph.D.³, (1)Lyles School of Civil Engineering, Purdue University, West Lafayette, IN, (2)Oak Ridge National Lab, Oak Ridge, TN, (3)Oak Ridge National Laboratory, Oak Ridge, TN

9:45 AM - 10:45 AM

Paper Session 4

Managing Comfort and Energy: Thermal Distribution, Demand-Controlled Ventilation and Occupancy-Based Vents

Track: *Ventilation, Indoor Air Quality and Air Distribution Systems*



Room: Great Lakes G

Chair: Kristen Sara Cetin, PE, Full Member, Michigan State University, EAST LANSING, MI

This session covers the importance of maintaining a highly controlled environment in cleanrooms to prevent contamination, specifically in optical fabs; ASHRAE RP-1747, which is a CO₂-based demand-controlled ventilation approach that uses trim and respond logic to dynamically adjust AHU and VAV terminal units' damper positions based on zones' ventilation requirements; and ventilation analysis of occupancy-based smart vent for a residential house.

1. Implementation of RP-1747 Demand-Controlled Ventilation in an Office Building: Preliminary Results from the Cooling Season (CH-24-C010)

Brodie William Hobson, Student¹, Andre Markus, PhD Candidate, Student¹, Jayson F Bursill, Ph.D, P.Eng., Full Member², Burak Gunay, Associate¹, Farzeen Rizvi³ and Zheng O'Neill, Ph.D., P.E., Fellow Member⁴, (1)Carleton University, Ottawa, ON, Canada, (2)Delta Controls Inc., Gloucester, ON, Canada, (3)National Research Council Canada, Ottawa, ON, Canada, (4)Texas A&M University, College Station, TX

2. Performance Improvement of Airflow and Thermal Distribution in a Cleanroom for Optical Fabs (CH-24-C009)

Indra Permana, Student¹, Alya Penta Agharid, Student Member² and Fujen Wang, Ph.D., P.E., Fellow ASHRAE², (1)National Chin-Yi University of Tech, WALNUT, CA, (2)National Chin-Yi University of Technology, Taichung, Taiwan

3. Development and CFD Simulation of Occupancy-Based Smart Vent for Residential House (CH-24-C011)

Zhipeng Deng, Student and Bing Dong, Ph.D., S-B-a Member, Syracuse University, Syracuse, NY

9:45 AM - 10:45 AM

Seminar 5 (Basic)

ASHRAE Conference Crash Course

Track: Fundamentals and Applications

Room: Great Lakes B

Sponsor: Young Engineers in ASHRE Committee

Chair: Marie Grace VanderVliet, Associate, Mechanical Products NSW, Salt Lake City, UT

First time at an ASHRAE Conference? Been coming for years, but still confused? What is a TC? What is a Standing Committee? Who can attend what? What is the AHR Expo? And why is all this happening at once? This crash course provides all attendees with an introduction to all the ASHRAE Conference activities, explains how you can get involved, and allows you to ask questions to experienced attendees.

1. The Ins and Outs of ASHRAE

Cailin MacPherson, P.Eng., MacPherson Engineering, SK, Canada

2. Getting Technical: An Overview of ASHRAE's Technical Offerings

Ben Bingham, Associate, Hoffman and Hoffman

3. Make the Most of Your Conference Experience

Joshua Vasudevan, Eng, Associate, Chord Consult, Loughborough, United Kingdom

9:45 AM - 10:45 AM

Seminar 6 (Basic)

Decarbonization in Cold Chain Process

Track: Refrigeration and Refrigerants



Room: Great Lakes C

Sponsor: 10.2 Refrigeration Applications, 10.1 Custom Engineered Refrigeration Systems

Chair: Kathleen A Neault, P eng, Full Member, Refri-Ozone Inc, Granby, QC, Canada

There is an increased focus on decarbonization of industrial processes. The first step in decarbonization is reducing energy consumption of fossil fuel. It starts by closely looking at the whole process and establishing where quick wins are that, without significant cost, such as reducing the primary energy usage, optimizing the design of the refrigeration system. The next step is to establish where waste energy or waste heat from one process can be used in other parts of it. This seminar proposes an evaluation of performance and the improvement of a blast freezer, and the optimization of the heat recovery.

1. Performance Evaluation and Improvement of Low Temperature Blast Freezing Systems

Douglas T Reindl, PE, Fellow Member, Univ of Wisconsin-Madison, Madison, WI

9:45 AM - 10:45 AM

Seminar 7 (Intermediate)

Duct Static Pressure Optimization in Labs: Saving Energy without Compromising Safety!

Track: Labs, Clean Spaces and Mission Critical Facilities



Room: Water Tower A

Sponsor: 9.10 Laboratory Systems, 1.4 Control Theory and Application

Chair: Ryan Soo, Associate, Siemens, Chicago, IL

Duct static pressure resets in VAV systems have been a well-established prescriptive requirement. But applying it in laboratory VAV systems requires careful considerations. Reducing duct static pressure will impact performance and therefore containment of hazards with possible safety implications. This seminar will discuss the considerations and strategies for duct static pressure resets without compromising on the safety of lab users.

1. Static Pressure Optimization: Considerations from a TAB and Cx Perspective

Justin F Garner, PE, CxA, Full Member, Engineered Air Balance Company Inc, Spring, TX

2. Risk-Based Lab Exhaust Optimization: Delivering the Right Pressure in the Right Place at the Right Time

Paul Albert Fuson, Full Member, Siemens, Buffalo Grove, IL

9:45 AM - 10:45 AM

Seminar 8 (Basic)

The Logical Way to Tap Into Decarbonization: Hydronic District Energy Systems

Track: Hydronic Systems



Room: Great Lakes E

Sponsor: 6.1 Hydronic and Steam Equipment and Systems, 6.6 Service Water Heating Systems, 6.2 District Energy

Chair: Robert Bean, Indoor Climate Consultants Inc., Chestermere, AB, Canada

Tapping into hydronic based district energy systems enables decentralized domestic water heating systems to achieve their maximum benefits including simplification, cost reductions, improved energy and exergy efficiencies.

1. Large-Scale Integrated Heating and Cooling with Full Hydronics: Choices and Implications

Drew Scott Turner, Director, Danfoss, Full Member, Danfoss, Pueblo, CO

2. District Energy: Best Practice Design, Lessons Learnt and How to Overcome Inefficiency

Tony Furst, Armstrong Fluid Technology, Delaware, OH

3. Tapped in, Connected, Conditioned and Controlled: Decentralized Domestic Water Is Integral to Decarbonization

Hailey Mick, BChE, Member, Uponor (North America), Apple Valley, MN

9:45 AM - 10:45 AM

Forum 1

Can We Engineer for Decarbonization?

Track: Decarbonization and Climate Change

Room: Water Tower B

Sponsor: 9.1 Large Building Air-Conditioning Systems

Chair: Kelley P Cramm, P.E., Life Member, Henderson Engineers, Overland Park, KS

Decarbonization has become the forefront of the movement to counter the effects of climate change. But what does this mean for consulting engineers tasked with implementing decarbonization in their designs? How does this effort affect our relationship to our clients and building owners, who hire us? What if building owners are not interested in decarbonization? This forum is intended to open a discussion about decarbonization in the context of the market and formulate ideas for how we can move toward mitigating climate change but still meet our obligations to our clients.

Sunday, January 21, 11:00 AM - 12:30 PM

Panel 3 (Intermediate)

LIVESTREAM: Harmony in Action: ASHRAE Standards Paving the Way for Building Decarbonization

Track: Decarbonization and Climate Change

Room: Great Lakes A

Sponsor: Task Force for Building Decarbonization; SSPC 100; Standard 240P

Chair: Bing Liu, PE, Fellow Member, Pacific Northwest National Laboratory, Portland, OR

For more than a hundred years, ASHRAE has led the charge in optimizing building design, operations, and HVAC&R technologies. Their unwavering dedication to robust standards and guidance drives continuous strides in energy efficiency and a clear path to decarbonization. This enlightening panel delves into how ASHRAE standards holistically tackle decarbonization, covering both operational and embodied carbon reductions for new and existing buildings throughout their entire life cycle. The panelists will also shed light on emerging challenges in refrigerant emissions amid the electrification of the built environment, as well as the pressing need for simplified codes and standards in developing economies.

1. ASHRAE Standards to Address Operational Carbon Reductions

Kent W Peterson, PE, Presidential Fellow Member, P2S Inc, Long Beach, CA

2. Standard 100's Role in Decarbonizing Existing Buildings

Glenn Friedman, PE, Fellow Life Member, Taylor Engineers, Alameda, CA

3. ASHRAE/ICC Standard 240P Update

Elizabeth K Tomlinson, PE, Full Member, Stantec, Calgary, AB, Canada

4. TFBF-Led Efforts to Develop the Simplified Decarbonization Codes Framework

Clay Nesler, The Nesler Group, Fort Myers, FL

5. Emerging Challenges in Refrigerant Emissions amid the Electrification of the Built Environment

Jim Young, Guidehouse, Inc., Burlington, MA

11:00 AM - 12:30 PM

Paper Session 5

Role of Optimization and Data-Driven Methods in Supporting Energy-Efficient Buildings

Track: Decarbonization and Climate Change



Room: Great Lakes F

Chair: John Dunlap, Fellow ASHRAE, Salas O'Brien, Richmond, VA

The growing concern for environmental sustainability has intensified efforts to enhance energy efficiency in the built environment. This session focuses on the crucial contribution of optimization and data-driven methodologies in propelling advancements in energy-efficient building practices. It underscores the significance of collecting and utilizing 'data' related to building energy efficiency and its pivotal role in supporting optimization. Various case studies were conducted to illustrate using diverse 'data' for decision-making in building retrofitting, energy prediction, and control optimization.

1. Identifying High VAV Minimum Airflow Rates and Potential Energy Savings: Developing a Screening Tool for HVAC Retrofits in Commercial and Institutional Buildings (CH-24-C012)

Marya Thawer, Student¹ and Paul Raftery, PhD, Full Member², (1)University of California Berkeley, BERKELEY, CA, (2)Center for the Built Environment, UC Berkeley, Berkeley, CA

2. A Comparative Investigation of Conventional and Data-Driven Surrogate Optimization Methods for Early Phase Building Energy Retrofit Analyses (CH-24-C013)

Mostafa M. Saad, Student, Ahmed Fayed and Ursula Eicker, Concordia University, Montreal, QC, Canada

3. Data-Driven Modeling of IoT-Based Smart Buildings for Energy Prediction and Optimization (CH-24-C014)

Dikai Xu, Student¹, Jaewoo Shin², Kayla Xu³, Ananth Grama² and Ming Qu, PhD, Full Member¹, (1)Lyles School of Civil Engineering, Purdue University, West Lafayette, IN, (2)Department of Computer Science, Purdue University, West Lafayette, IN, (3)West Lafayette Jr./Sr. High School, West Lafayette, IN

4. CHP Digital-Twin-Model for Control Optimization and Transition to Renewable Based Fuels (CH-24-C015)

Michael Huylo, PE, Full Member¹ and Atila Novoselac, PhD, Associate², (1)University Of Texas, Austin, TX, (2)University Of Texas, AUSTIN, TX

5. Multi-Criteria Evaluation of Commercial Buildings with Poly-Generation System in South Korea (CH-24-C016)

Junyeol Jung, Student and Hoseong Lee, Korea University, Seoul, Korea, Republic of (South)

11:00 AM - 12:30 PM

Paper Session 6

IEQ Sensing, Smart Thermostats and Controls

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Great Lakes G

Chair: Christine Reinders-Caron, Full Member, Iowa State University, Des Moines, IA

Residential gas stoves and the pollutants from residential natural gas burners are in the news. Residential cooking generates contaminants of concern from the heat source (gas or electric) and cooking process itself. Design and operational parameters can affect the ventilation performance of residential kitchens. This session highlights the field observations regarding the performance and usage of residential kitchen ventilation; recent changes to metrics and test methods for residential range hoods; and CFD analyses of kitchen ventilation. This session provides high-level guidance for proper design and operation of ventilation systems in residential kitchens to limit exposure to pollutants generated by cooking.

1. Optimal Window Properties Considering Energy Use and Visual Comfort Under Uncertain Shading Configurations (CH-24-C112)

Sichen Lu, Student¹ and Athanasios Tzempelikos, PhD, Full Member², (1)Purdue University, West Lafayette, IN, (2)Purdue University - Civil Engineering, West Lafayette, IN

2. Trends and Changes in U.S. Residential Occupancy and Activity Patterns across Demographics during and Post-COVID (CH-24-C043)

Hao Dong, Student¹, Debrudra Mitra, Student² and Kristen Cetin², (1)Michigan State University, EAST LANSING, MI, (2)Michigan State University, East Lansing, MI

3. Rural Midwest Homeowners' Perceptions of Smart Thermostats (CH-24-C045)

Noah Dreiling, Student¹, Kristen Sara Cetin, PE, Full Member¹, Patricia Guillante, Student² and Zoe Linko³, (1)Michigan State University, EAST LANSING, MI, (2)Michigan State University, (3)Michigan State University, East Lansing, MI

4. Social Energy Games for Smart and Energy-Efficient Multi-Unit Residential Buildings: Mechanism Design (CH-24-C046)

Huijeong Kim, Student Member¹, Panagiota Karava, Ph.D., Associate Member¹, Ilias Bilionis, Ph.D.¹ and James Braun, Ph.D., Fellow ASHRAE², (1)Center for High Performance Buildings, Purdue University, West Lafayette, IN, (2)Ray W. Herrick Laboratories, Purdue University, West Lafayette, IN

5. Leveraging Humans As Effective Sensors for Indoor Environmental Quality Evaluation through Text-Mining Temporary Residence Reviews (CH-24-C042)

Qi Zhang, Student¹, Shundong Li², Jian Hu³ and Nan Ma, Affiliate⁴, (1)Tongji University, Shanghai, China, (2)Worcester Polytechnic Institute, Worcester, MA, (3)Emory University, Atlanta, GA, (4)Worcester Polytechnic Institute, WORCESTER, MA

11:00 AM - 12:30 PM

Seminar 9 (Advanced)

Frost Mitigation: Air-to-Refrigerant Heat Exchangers, Experiments and Modeling

Track: Fundamentals and Applications



Room: Water Tower A

Sponsor: 8.4 Air-to-Refrigerant Heat Transfer Equipment, 1.3 Heat Transfer and Fluid Flow

Chair: Pedro Perez, Associate, AAON, INC., MERRITT ISLAND, FL, United States

Heat Exchangers in Air-Source Heat Pumps, Refrigeration and many other applications are subject to frost accumulation. Frost reduces system capacity due to reduced airflow and added thermal resistance. Defrost cycles and lower setpoints are some of the measures used to mitigate the effect of frost during operation. This seminar presents simulation and experimental results studying the effects of surface wettability, air contaminants, contact angle and air temperature setpoints in frost formation. It also discusses the integration of frost formation and melting models in dynamic simulations with the potential to improve control and fault detection algorithms in air-source heat pumps.

1. Effects of Surface Wettability and Particle Contamination on the Initial Frost Formation

Lorenzo Cremaschi, PhD, S-B-a Member, Auburn University, Auburn, AL

2. The Role of Surface Wettability in Condensate and Frost Management: A Condensed View of the Topic

Andrew Sommers, Professor, Associate, Miami University Ohio, Oxford, OH

3. Freezer Frost Is Not Created Equal: What to Do When Walk-in Freezer Air Temperature Starts to Rise

S a A Sherif, PhD, BCxP, Fellow Life S-B-a Member, University of Florida, Gainesville, FL

4. Dynamic Modeling of Air-Source Heat Pumps Under Cycling of Non-Uniform Frosting and Defrosting
Jiacheng Ma, Student, Purdue University, W Lafayette, IN

11:00 AM - 12:30 PM

Seminar 10 (Intermediate)

Impact of Occupant Behaviour on Demand Response

Track: HVAC&R Controls



Room: Water Tower B

Sponsor: 7.5 Smart Building Systems

Chair: Burak Gunay, Associate, Carleton University, Ottawa, ON, Canada

Occupants are the ones that ultimately decide whether or not to adapt their energy use behaviour subject to dynamic utility price signals or to override or accept a direct load control sequence. Thus, occupant behaviour represents a major source of uncertainty for the success of demand response programs. A better understanding of human factors will inform the next-generation feedback interfaces that effectively nudge on-peak electricity use behaviour and direct load control sequences that take advantage of continuous occupant feedback. This seminar will present studies demonstrating how occupant data can be used to maximize the effectiveness of demand response programs.

1. Modelling Residential Occupant Behaviour at Scale to Inform Demand-Response Implementation

Mohamed Ouf, Associate, Concordia University, Montreal, QC, Canada

2. Human-Centric Automation in Energy Demand Response: Unveiling Discomfort-Driven Occupant Behavior

Michael Bruce Kane, Ph.D., Full Member, Northeastern University, BOSTON, MA

3. Quantifying Energy Flexibility from Advanced Control of DER and Occupant Interaction in Citylearn

Kingsley Etonwana Nweye, Student, University of Texas at Austin, Austin, TX

4. Understanding the Effect of Occupant Behaviour on Peak Demand

Ajit Pardasani, National Research Council, Ottawa, ON, Canada

5. Occupants' Thermostat Use Behaviour during Direct Load Control Events

Burak Gunay, Associate, Carleton University, Ottawa, ON, Canada

11:00 AM - 12:30 PM

Seminar 11 (Intermediate)

Lessons Learned and Engineer Rules on CFD Applications in Data Center Design

Track: Labs, Clean Spaces and Mission Critical Facilities



Room: Great Lakes B

Sponsor: 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment, 4.10 Indoor Environmental Modeling

Chair: Eric Yang, PE, Full Member, Vantage Data Center, Vienna, VA

Computational fluid dynamics is a widely used tool to design data center applications. This session brings you a team of experts and provides lessons learned on the CFD applications of Data Center, such as the wind effect modeling, engineering rules, and special challenges in mixed Density / Mixed Cooling Topologies.

1. Busting Myths of Data Center Cooling

James W VanGilder, PE, Full Member, Schneider Electric, Andover, MA

2. Fact or Fiction? Engineering Rules for Data Center CFD Modeling

Mark James Seymour, P.E., Full Member, Cadence Design Systems, Wincanton, United Kingdom

3. Challenges of CFD Modeling for Mixed Density / Mixed Cooling Topologies in Data Center Design

David V Quirk, PE, Full Member, DLB Associates, Eatontown, NJ

4. How Wind Affects Your Data Center Building Design

Mikhail Koupriyanov, P.Eng., M.A.Sc. P.Eng., Associate, Price Industries Ltd., Winnipeg, MB, Canada

11:00 AM - 12:30 PM

Seminar 12 (Intermediate)

The Optimal Indoor: Utilizing Data for Precision Cultivation Climate Control

Track: HVAC&R Systems and Equipment



Room: Great Lakes C

Sponsor: 2.2 Plant and Animal Environment, MTG CEA

Chair: William Alexander Stober, Associate, Red Car Analytics, Santa Rosa, CA

Maintaining optimal climate conditions is one of the most critical facets of indoor cultivation. This seminar emphasizes the importance of harnessing data and scientific understanding to refine these conditions. Attendees will gain detailed insights into the characterization of thermal loads and their variability, facilitating the optimization of HVAC and dehumidification system designs for maximum energy efficiency and cultivation success. Furthermore, the significance of comprehensive data monitoring will be highlighted. Demonstrations will showcase how facility owners can use these systems to understand their cultivation site's ecosystem deeply, ensuring seamless operation and enhanced productivity.

1. Climate Control: Thermal Load Characterization and Connection to Plant Health

William Alexander Stober, Associate, Stober Engineering, Santa Rosa, CA

2. Utilizing Thermal Load Data for HVAC Design and Precise Control

Adrian B Giovenco, Full Member, InSpire Transpiration Solutions, Berkeley, CA

4. Designing and Building HVAC Systems for CEA for Long Term Life

Michael J Gillespie III, PE, Full Member, Gillie Consulting Services, Shohola, PA

11:00 AM - 12:30 PM

Seminar 13 (Intermediate)

Thermal Energy Storage: A Critical Strategy for Decarbonization

Track: Decarbonization and Climate Change



Room: Great Lakes E

Sponsor: 6.9 Thermal Storage

Chair: Sven Mumme, Department of Energy, Building Technologies Office, DC

Cost-effective energy storage is necessary for the large-scale deployment of renewable electricity, electrification and decarbonization—and essential for meeting clean energy goals. Currently, as much as 50% of electricity consumption in buildings in the United States goes toward meeting thermal loads. Thermal energy storage (TES) solutions show promise as a cost-effective energy storage alternative, and recently a consortium was formed to catalyze development of such systems. This session explores integration of thermal storage with HVAC, beginning with research objectives and opportunities, and then exploring several specific integration approaches.

1. R&D Challenges and Opportunities in Thermal Energy Storage for Decarbonization

Sven Mumme, Department of Energy, Building Technologies Office, DC

2. Integrating Thermal Energy Storage into Packaged HVAC Systems

Jason D Woods, PhD, Associate, National Renewable Energy Laboratory, WASHINGTON, DC

3. Development and Control of Integrated HVAC with TES

Spencer Maxwell Dutton, PhD, Lawrence Berkeley National Laboratory, Berkeley, CA

4. Field-Tested Configurations That Integrate Thermal Storage with Vapor Compression

Kyle R Gluesenkamp, Ph.D., Full Member, Oak Ridge National Laboratory, OAK RIDGE, TN

Sunday, January 21, 1:30 PM - 3:00 PM

Panel 4 (Intermediate)

LIVESTREAM: Thermal/Fluid Applications of AI in Advancing Energy Efficiency of HVAC/R Equipment and Building Energy Systems

Track: Artificial Intelligence

Room: Great Lakes A

Sponsor: 1.3 Heat Transfer and Fluid Flow, TC 7.5, TC 8.5, TC 8.4, TC 1.1, TC 1.4

Chair: Michael Ohadi, University of Maryland, College Park, MD

AI (Artificial Intelligence) and ML (Machine Learning) are crucial for energy efficiency advancement of HVAC/R equipment and building energy systems. Applying AI and ML in HVAC/R equipment and building energy systems can lead to significant energy savings, reduced carbon emissions, improved occupant comfort, and highly optimized building operations. In the proposed panel, four leading experts will discuss case examples of AI and ML applications in advancing HVAC/R equipment and building energy systems decarbonization and sustainability.

1. The Role of AI on Next-Generation Heat Exchangers for Heat Pumps and Heat Pump Water Heaters

Kashif Nawaz, PhD, Associate, Oak Ridge National Lab, Oak Ridge, TN

2. Application of Machine Learning for Improving Energy Efficiency of Data Centers

Yogendra Joshi, PhD, Georgia Institute of Technology, Atlanta, GA

3. AI/ML-Enabled Innovation in Heat Exchangers for the Built Environment

Vikrant C Aute, Ph.D., Fellow Member, University of Maryland, COLLEGE PARK, MD

4. Case Examples of Advanced Technology Needs for HVAC/R and Building Energy Systems

Marina Sofos, PhD, U.S. Department of Energy, Washington, DC

1:30 PM - 3:00 PM

Paper Session 7

Control Applications and Model Predictive Controls

Track: HVAC&R Controls



Room: Great Lakes F

Chair: Dawen Lu, Full Member, Lu + S Engineers PLLC, Glen Allen, VA

This session presents various applications of controls: supervisory controller in a real-world residential building; optimal DOAS control; hybrid heating system; and model-based observer to estimate hot water draws in heat pump water heaters using tank temperature measurements.

1. Latent and Sensible Model Predictive Controller Demonstration in a House during Cooling Operation (CH-24-C022)

Elias Nikolaos Pergantis, Eng, Student, Purdue University - Ray W. Herrick Laboratories, West Lafayette, IN

2. Large-Scale Energy Saving Potential Analysis for Primary Schools with Optimal Dedicated Outdoor Air System Control (CH-24-C023)

Youngsik Choi, Student¹, Xing Lu, Associate², Fan Feng, Student³ and Zheng O'Neill, Ph.D., P.E., Fellow Member⁴, (1)Texas A&M University, COLLEGE STATION, TX, (2)Pacific NorthWest National Laboratory, College Station, TX, (3)Texas A&M University, College Station, TX, (4)Texas A&M University, College Station, TX

3. Hybrid Heat Pump System's Control Optimization for Annual Heating Operating Cost and Emission Minimization (CH-24-C024)

Navin Kumar, Ph.D., Associate¹, Alejandro Baez Guada, Associate Member², Tim Kingston, Associate², Paul D Armatas, Student³ and Ryan Kerr², (1)GTI ENERGY, Des Plaines, IL, (2)GTI Energy, Des Plaines, IL, (3)Oregon State University, Corvallis, OR

4. Modeling and Validation of a Residential Multi-Functional Variable Refrigerant Flow Heat Pump System with Heat Recovery for Control Applications (CH-24-C025)

Junke Wang, Associate, Xing Lu, Ph.D., Associate Member, Edward P Louie and Veronica A Adetola, Full Member, Pacific Northwest National Laboratory, Richland, WA

5. Hot Water Draw Estimation and Prediction for Economic Model Predictive Control of Heat Pump Water Heaters (CH-24-C026)

Loren Dela Rosa, Student¹, Caton Mande, Student² and Matthew J Ellis¹, (1)UC Davis Chemical Engineering, Davis, CA, (2)Western Cooling Efficiency Center, Davis, CA

1:30 PM - 3:00 PM

Paper Session 8

Energy Management, Demand Response Flexibility and Leveraging Building Energy Models

Track: Decarbonization and Climate Change



Room: Great Lakes G

Chair: Harry J Enck, Full Member, Commissioning & Green Build Solutions, Inc, Lawrenceville, GA

This session begins with a paper presenting a 'revolutionary energy management paradigm' shift. Other papers the load flexibility of systems and another a novel workflow to perform thermal resilience analysis.

1. Revolutionary Energy Management: Rethinking the Paradigm (CH-24-C027)

Chris Thompson, Full Member, Engenuity Systems, Irving, TX

2. Flexibility Potential of Residential Heat Pumps in the Power Grid of the Future (CH-24-C028)

Wolf Bracke, Mohsen Sharifi, Sam Hamels, Jelle Laverge and Marc Delghust, Ghent University, Ghent, Belgium

3. Load Flexibility of a Residential Multi-Function Heat Pump Using Dynamic Pricing (CH-24-C029)

Christy D Green, PhD, Student¹, Subhrajit Chakraborty, P.E., Student² and David R Vernon, PhD, Full Member³, (1)University of California, Davis, Davis, CA, (2)University of California Davis, Davis, CA, (3)Western Cooling Efficiency Center, UC Davis, Davis, CA

4. Assessing Demand Response Flexibility of Home Appliances: The Role of Household Heterogeneity and Activities (CH-24-C030)

Mohamed Osman, Student and Mohamed Ouf, Associate, Concordia University, Montreal, QC, Canada

5. Leverage Building Energy Models to Perform Thermal Resilience Analysis: A Novel Workflow (CH-24-C031)

Chun Yin Siu, Student¹, Marianne Touchie² and William T O'Brien, PhD, Associate³, (1)University of Toronto, Toronto, ON, Canada, (2)University of Toronto, Toronto, Canada, (3)Carleton University, Ottawa, ON, Canada

1:30 PM - 3:00 PM

Seminar 14 (Intermediate)

Advancements in Liquid Cooling Applications for Data Centers

Track: Labs, Clean Spaces and Mission Critical Facilities

Room: Water Tower A

Sponsor: 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

Chair: Eric Yang, PE, Full Member, Vantage Data Center, Vienna, VA

New computer processor designs are making new applications available every year, but these new processors are also often generating more heat. To meet the need to cool these processors, many new technologies have been introduced in the marketplace. This seminar discusses the trend in computer processor power and present the fundamentals of many of the new liquid cooling innovations used to cool them. In addition, attendees will learn how ASHRAE is aiding in this technology transition through the expansion of (SSPC 127) to cover data center liquid cooling products.

1. Current Trends in Computer Processor Power and Design

Paul Artman, BEAP, Advanced Micro Devices, Sunnyvale, CA

2. The Fundamentals of Data Center Liquid Cooling Technologies and How They are Deployed

Jason Matteson, Iceotope, Catcliffe, United Kingdom

3. ASHRAE Standard Activities on Liquid Cooling

Tim Shedd, PhD, Fellow ASHRAE, Dell, Tampa, FL

1:30 PM - 3:00 PM

Seminar 15 (Intermediate)

Building Operations under the “New Normal” of Reduced Occupancy

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Water Tower B

Sponsor: MTG.OBB Occupant Behavior in Buildings, 7.9 Building Commissioning

Chair: Mohamed Ouf, Associate, Concordia University, Montreal, QC, Canada

Building occupancy patterns dramatically changed after the COVID-19 pandemic, given the shift towards flexible work arrangements which are here to stay. These changes resulted in significantly lower occupancy in commercial buildings than traditionally assumed, yet their impact on energy demand remains minimal, raising numerous opportunities for optimizing building operations. Thanks to recent advancements in sensing infrastructure, more granular information on building occupants can be leveraged to adapt building operations to reduced and more variable occupancy. To this end, this seminar presents recent work that introduced different strategies to optimize building operations under the “new normal” of reduced occupancy.

1. Improving Occupant Comfort in Multi-Occupant Spaces with Variable Occupancy

Mohamed Ouf, Associate, Concordia University, Montreal, QC, Canada

2. The Energy Impact of Telework and Building Design Strategies and Policies to Mitigate Negative Impacts

William T O'Brien, PhD, Associate, Carleton University, Ottawa, ON, Canada

3. Improving Building Design and Operation for Variable Occupancy

Tianzhen Hong, PE, Fellow Member, LBNL, Berkeley, CA

4. DCV Application of Virtual Flow Meter for Outdoor Airflow Control Under Variable Occupancy

Gang Wang, PhD, S-B-a Member, University of Miami, Coral Gables, FL

1:30 PM - 3:00 PM

Seminar 16 (Intermediate)

Cutting-Edge Japanese Technologies on IEQ and Energy Efficiency: SHASE Annual Award Winner

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Great Lakes B

Chair: Takashi Akimoto, Professor, Full Member, Shibaura Institute of Technology, Tokyo, Japan

Three SHASE Annual Award-winning buildings featuring advanced IEQ and energy efficiency are presented. The first is a research facility that introduces an air conditioning system with no ambient air temperature and humidity settings, but which has three types of personal air conditioners controlled by smartphones. The second is an office building that developed and compared two systems, a ductless VAV system using the Coanda effect and a radiant air-conditioning system with variable temperature/water volume control. The third is a one-room multi-story university building connected by a large atrium where air conditioning is controlled by image sensors.

1. An Air-Conditioning System that Can be Adapted to Personal Preferences with No Indoor Temperature and Humidity Setting

Kentaro Kimura, Senior Research Engineer, Full Member, Takasago Thermal Engineering Co., Ltd., Ibaraki, Japan

2. Convective and Radiant Air Conditioning Systems in a Tenant Building with Low Floor Heights Designed to Achieve Comfort and Energy Conservation

Nobuhiro Hirasuga, Eng, Associate, Mitsubishi Jisho Design Inc., Tokyo, Japan

3. An Air-Conditioning System in a One-Room Multi-Story University Building Controlled by Image Sensors

Tatsunori Maeda, Senior Chief Engineer, Takenaka Corporation, Osaka, Japan

1:30 PM - 3:00 PM

Seminar 17 (Intermediate)

Relationships and Coordination Needs Among ASHRAE Standards and Guidelines

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Great Lakes C

Sponsor: SPGC10 (Primary) and SSPC62.1 (Co-sponsor)

Chair: Charlene W Bayer, PhD, Fellow Life Member, Hygieia Sciences LLC, MARIETTA, GA, United States

ASHRAE has 241 existing standards, over 40 guidelines and multiple technical committees. There are similarities of goals and purpose of many of these efforts with minimal discussion of potential relationships between each of these. The primary interaction is by committee members existing on multiple committees rather than a concerted effort for coordination. For example, there are multiple standards and guidelines setting ventilation standards. This seminar examines and discusses the need for greater coordination and interaction throughout ASHRAE for more effective requirements and guidance to the ASHRAE and design communities.

1. Relationships and Coordination Needs Among ASHRAE Ventilation Standards and Guidelines

Hoy R Bohanon Jr, PE, Life Member, Hoy Bohanon Engineering, PLLC, Denver, CO

2. Coordination Efforts Related to Ventilation and Acceptable Indoor Air Quality (SSPC 62.1)

Wayne R Thomann, Retired, Full Member, Duke University, Durham, NC

3. Guideline 10 As a Framework for Exploring Inter-related Definitions and Processes Among the "Silos" of Current ASHRAE Standards and Guidelines

Carl Grimes, HHS CIEC, Full Member, Hayward Healthy Home, Denver, CO

4. Coordination Among ASHRAE Decarbonization Standards

Luke C H Leung, PE, BEMP, Fellow Member, SKIDMORE, OWINGS & MERRILL, Chicago, IL

1:30 PM - 3:00 PM

Seminar 18 (Basic)

Thinking Outside the Box: Using 40% Tax Credits for Thermal Storage Systems

Track: HVAC&R Systems and Equipment



Room: Great Lakes E

Sponsor: 6.9 Thermal Storage

Chair: Daniel Richard Pyewell, Associate, Tanco Engineering, Loveland, CO

The Inflation Reduction Act of 2022 provides tax credits for thermal energy storage systems in residential and commercial buildings. Project engineers will be challenged to think outside the box and develop new solutions. This will include using ice storage to heat buildings in cold climates (< 0F), using phase change materials to shift peak electric demand in cold storage warehouses and grocery stores, and improving the effectiveness and efficiency of dedicated outdoor air systems (DOAS).

1. Heating with Ice: Status of Pilot Project in Wisconsin Training Facility

Brian Fiegen, Systems Development Leader, Full Member, Trane Technologies, Melbourne, FL

2. Phase Change Materials for Thermal Storage in Warehouses

Stan Nabonzy, Director of Thermal Energy Storage, Member, Michaels Energy, LaCrosse, WI

3. Ice Storage and DOAS Optimization

Bruce B Lindsay, PE, Life Member, Trane Technologies, Melbourne, FL

Sunday, January 21, 3:15 PM - 4:45 PM

Paper Session 9

Energy Systems, Hydrogen-Ready Heating and Venture Steam Trap

Track: HVAC&R Systems and Equipment



Room: Great Lakes F

Chair: Songhao Wu, Student, Purdue University, W LAFAYETTE, IN

This session presents a wide-range of paper topics with a focus on packaged air-conditioning units. A study on integrated energy systems for multi-family end-use load covers EV charging. Rounding out the session is a paper exploring if the heating industry is hydrogen-ready and one on laboratory and field evaluation studies of Venturi steam traps.

1. Retrofit and Experimental Validation of a Packaged Air-Conditioning Unit with Heat Exchangers Utilizing Shape- and Topology-Optimized Tube Bundles (CH-24-C032)

Ellery Klein¹, James Tancabel, PhD, Affiliate², Vikrant C Aute, Ph.D., Fellow Member³, Jan Muehlbauer¹, Yunho Hwang, PhD, Fellow Member¹ and Reinhard Radermacher¹, (1)University of Maryland, College Park, MD, (2)University of Maryland, College Park, College Park, MD, (3)University of Maryland, COLLEGE PARK, MD

2. Benefits of Integrated Energy Systems for Multi-Family End-Use Load Including EV Charging (CH-24-C033)

Alejandro Baez Guada, Associate Member, Tim Kingston, Associate, Paul D Armatas, Student and Jason Lefleur, GTI Energy, Des Plaines, IL

3. Laboratory Evaluation and Modeled Energy Savings of High-Efficiency Motor and Drive Systems for Packaged HVAC Units (CH-24-C034)

Frederick Nicholas Meyers, Associate¹, Raymond Breault¹, Jonathan Hollist, Full Member², David R Vernon, PhD, Full Member¹ and Theresa Pistochini, Full Member¹, (1)Western Cooling Efficiency Center, UC Davis, Davis, CA, (2)Research and Development Engineer, WCEC, UC Davis, Davis, CA

4. Is the Heating Industry Hydrogen-Ready? A Meta-Analysis of Hydrogen Impact Assessments of Building Heating Equipment (CH-24-C035)

Paul E Glanville, PE, Associate¹, William Asher, Ph.D., Associate², Alex Fridlyand, Ph.D., Associate³, Tanmay Kar, Dr⁴ and Yan Zhao, Full Member¹, (1)Gas Technology Institute, Davis, CA, United States, (2)GTI, Des Plaines, IL, (3)GTI Energy, Davis, CA, United States, (4)GTI Energy, Des Plaines, IL

5. Venturi Steam Trap Evaluations Results and Application Guidelines (CH-24-C036)

Arjun Thirumaran, Associate and Hardik Shah, GTI Energy, Des Plaines, IL

3:15 PM - 4:45 PM

Seminar 19 (Intermediate)

LIVESTREAM: Beneficial Electrification

Track: HVAC&R Systems and Equipment



Room: Great Lakes A

Sponsor: 2.8 Building Environmental Impacts and Sustainability, 6.8 Geothermal Heat Pump and Energy Recovery Applications, 4.2 Climatic Information

Chair: Svein O Morner, Full Member, HGA, Inc, Middleton, WI

Electrification is a common topic on many building owners' agenda. Many owners are being pushed to decarbonize their building or campus. In some owners' mind, this mostly requires reducing the scope 1 (direct combustion in building or campus) emissions but this simple approach can cause scope 2 emissions to exceed the scope 1 savings, resulting in a net increase in carbon dioxide emissions. Heat pump systems, and specifically ground source heat pumps, in colder climates can accomplish a reduction or elimination of scope 1 emissions without increasing the resulting scope 2 emissions, i.e. beneficial electrification.

1. Beneficial Electrification of Mcfarland, WI Public Safety Building

Andrew A DeRocher, Full Member, HGA, MINNEAPOLIS, MN, United States

2. Comed Schools Electrification

Andrew George Wiegand, Full Member, MichaelsEnergy, La Crosse, WI

3. Dunkelflaute (Dark Doldrums) Defrosting of Air-Source Heat Pumps

Eric L Peterson, PhD, PE, CEEng, Full Member, Visiting Research Fellow-Univ. of LEEDS, Leeds, West Yorkshire, United Kingdom

4. Comprehensive Decarbonization Planning for Diverse County-Owned Buildings

Russell Knudson, pe, BCxP, Associate, HGA, MINNEAPOLIS, MN, United States

3:15 PM - 4:45 PM

Seminar 65 (Advanced)

Role of Lubricant Operation and Stability for Low GWP Refrigerants

Track: Refrigeration and Refrigerants

Room: Great Lakes B

Sponsor: 3.4 Lubrication, 3.2 Refrigerant System Chemistry and Contaminant Control , 3.1 Refrigerants and Secondary Coolants

Chair: Raymond Drost, Associate, Calumet Specialty Products Partners, L.P., Indianapolis, IN

Basic principles still exist, regardless of what refrigerant is used in a compressor and system. Lubrication of the compressor is essential to system longevity and matching up refrigerants and lubricants for optimal performance. The variety of next generation refrigerants creates the need to understand the interaction with lubricants and ways to evaluate for decision making. Understanding the basic concepts and implementing them in testing can help minimize cost and time to market. Various principles will be discussed in the seminar that benefit compressor and system performance.

1. Steps to Qualify Lubricants and Next Generation Refrigerants

Joseph A Karnaz, Full Member, Shrieve Chemical Products, LLC, The Woodlands, TX

2. Influence of Lubricants on the Heat Transfer with Refrigerants in Pool Boiling and Flow Boiling Systems

Jung-Tsung Hung, Associate, Patech Fine Chemicals Co., Ltd.

3. Impact of Lubricant Chemistry on Chemical Stability of Low GWP Refrigerants

Stephen Kujak, Full Member, Trane

4. Wear Behavior of Steel Under Different Refrigerant Systems

Wasim Akram, Trane Technologies

5. Stability Testing of Non-TFA Producing Refrigerants

Chris Seeton, Dr, Member, Koura, The Woodlands, TX

Monday, January 22

Monday, January 22, 8:00 AM - 9:30 AM

Panel 5 (Advanced)

Professional Liability: Sliding Doors/Changing Landscapes

Track: Fundamentals and Applications

Room: Great Lakes B

Sponsor: 1.7 Business, Management & General Legal Education, 7.2 HVAC&R Construction & Design Build Technologies , 7.1 Intergrated Building Design

Chair: Mitchell Swann, P.E., Life Member, Resolution Management Consultants, Philadelphia, PA

The landscape of project execution strategies has been rapidly changing. Collaborative strategies such as Integrated Project Delivery and Design-Build, along with hybrids like progressive D-D and design-assist change the relationship and sometimes roles of engineers and contractors. Increased use of contracts with 'performance' expectations (net zero, GHG emissions, GESCs, C-PACE, etc) and predictive modeling (i.e. BIM and BEM) have changed owner expectations. Come hear our diverse panel cover the ins, outs and roundabouts that are impacting Professional Liability and what the savvy practitioner should know.

1. Owner Perspective

Jennifer A Isenbeck, PE, Full Member, Moffitt Cancer Center, Tampa, FL

2. Designer Perspective

Mitchell Swann, P.E., Life Member, Resolution Management Consultants, Philadelphia, PA

3. Insurance Perspective

Sandip R. Chandarana, Professional Underwriters Agency, Oak Brook, IL

4. Legal Perspective

Jean M Terry, Manion Stigger LLP, Louisville, KY

8:00 AM - 9:30 AM

Paper Session 10

Building Energy Performance and Decarbonization

Track: Decarbonization and Climate Change



Room: Great Lakes F

Chair: Sonya M Pouncy, CEM, LEED AP, Full Member, Building Vitals, Detroit, MI

Building energy performance and decarbonization are critical in achieving sustainable development and combating climate change. This session examines pathways toward decarbonizing industry, campus, and multifamily buildings. It explores the technical, financial, and policy aspects and the formulation of an actionable roadmap aimed at realizing a carbon-neutral future by 2050. Additionally, a high R-value prefabricated envelope retrofitting panel prototype is showcased as an illustrative solution for achieving decarbonization objectives. This session underscores the critical importance of considering various factors in pursuing a sustainable and decarbonized built environment.

1. Industrial Energy Efficiency and Decarbonization: Identifying Motivations and Barriers for Midwest Manufacturers (CH-24-C037)

Andreana Louise Roxas¹, Aniruddha Naik², Kristen Cetin², Annick Anctil² and George Berghorn², (1)Michigan State University, EAST LANSING, MI, (2)Michigan State University, East Lansing, MI

2. Prefabricated R30 Retrofit Panel Development and Verification (CH-24-C038)

Kaushik Biswas, Ph.D.¹, Jason J LaFleur, Full Member², Carlos Ortiz¹, John Briggs³, Daniel Dwiggins³ and Edward Scherrer⁴, (1)GTI Energy, DAVIS, CA, (2)GTI Energy, Des Plaines, IL, (3)Fraunhofer USA CMI, Brookline, MA, (4)InSoFast, LLC, Mitchell, SD

3. Decarbonizing Large Existing Campus Buildings in a University Located in North America (CH-24-C039)

Gayatri Sundar Rajan, Student¹, Cathy Cheng², Sabrina Dilig², Amanda Baumann², Christopher Lambert², **Michael Gevelber, Associate Professor, Full Member¹**, Joseph Kajunsky² and Dennis Carlberg, Associate Vice President for University Sustainability at Boston University¹, (1)Boston University, Boston, MA, (2)Boston University

4. Fast and Effective Approach to Realize Ambitious Building Energy Performance Targets: Fastlane (CH-24-C040)

Thomas Verhoeven, MSc and **Wim Maassen, Full Member**, Royal HaskoningDHV, Rotterdam, Netherlands

5. Buildings of Excellence: Resilient, Carbon-Neutral Multifamily Design and Operation (CH-24-C041)

Carrie A Brown, Ph.D., Full Member, Resource Refocus LLC, Oakland, CA

8:00 AM - 9:30 AM

Paper Session 11

Update on Kitchen Ventilation Research

Track: Ventilation, Indoor Air Quality and Air Distribution Systems



Room: Great Lakes G

Chair: Lorenzo Cremaschi, PhD, S-B-a Member, Auburn University, Auburn University, AL

This session presents residential kitchen ventilation research on gas stoves, including a CFD analysis, range hoods and cooking emissions from various range tops. Mechanical Residential Kitchen ventilation performance is examined, also.

1. Analysis of Residential Kitchen Ventilation with a Gas Stove: A Mass Balance Approach (CH-24-C017)

Kishor K Khankari, PhD, Fellow Member, AnSight LLC, Ann Arbor, MI

2. CFD Analysis of Ventilation Performance of a Residential Kitchen with a Gas Stove (CH-24-C018)

Kishor K Khankari, PhD, Fellow Member, AnSight LLC, Ann Arbor, MI

3. Residential Range Hood Issue Brief (CH-24-C019)

Randall L Cooper, Full Member, Association of Home Appliance Manufacturers, Washington, DC

4. Cooking Emissions from Food for Natural Gas, Propane and Electric Range Tops (CH-24-C020)

Michael Frank Johnson, Ph.D., Associate, GTI Energy, Des Plaines, IL

5. Performance and Usage of Mechanical Residential Kitchen Ventilation (CH-24-C021)

Haoran Zhao, Student, Iain S Walker, PhD, Member, William W Delp, PhD and Brett Singer, Lawrence Berkeley Laboratory, Berkeley, CA

8:00 AM - 9:30 AM

Seminar 20 (Basic)

Best Practices of a Mentor-Mentee Relationship

Track: Fundamentals and Applications

Room: Great Lakes C

Sponsor: YEA Committee

Chair: Cailin MacPherson, P.Eng., Associate, Macpherson Engineering Inc, Regina, SK, Canada

ASHRAE advocates for mentoring as a powerful resource, fostering mutually beneficial relationships between mentors and mentees. Although ASHRAE does not have a formal mentorship program, the ASHRAE community is largely built on relationships made through its technical programs.

ASHRAE's grassroots nature as a community thrives on mentorship. Mentorship is a professional and personal relationship between an experienced mentor and a less-experienced mentee, enhancing the mentee's skills, knowledge, confidence, and competence. The mentorship workshop aims to help facilitate mentorship within ASHRAE and beyond by providing useful tools, examples of successful mentorship relationships and leading interactive discussions.

1. Introduction to Mentorship within ASHRAE and Beyond

Elizabeth Jedrlinic, Full Member, Trane, SAN JUAN, PR

2. Summary and Capture of Learnings and Actions Arising

Gary O'Sullivan

3. Personal Mentee Journeys from Existing Mentorship Programs

Adetunji Ifaturoti, Affiliate, Ethos Engineering

4. Unstructured Mentorship Programs in the Workplace

Tyler D Berry, Full Member, TLA Inc., Richmond, VA

8:00 AM - 9:30 AM

Seminar 21 (Intermediate)

LIVESTREAM: Artificial Intelligence for Building Performance Simulation

Track: Artificial Intelligence



Room: Great Lakes A

Sponsor: 4.7 Energy Calculations

Chair: Himanshu Sharma, Ph.D., Pacific Northwest National Laboratory, Downers Grove, IL

Machine learning (ML) models are increasingly being used to improve the performance of buildings. ML models can be used to predict energy consumption, occupant comfort, and other building performance metrics. They can also be used to optimize building operations, such as HVAC control and lighting schedules. This seminar explores the latest advances in ML for buildings performance modeling. We will discuss a variety of ML models, including regression models, classification models and neural networks. We will also discuss the challenges of applying ML to buildings, such as data availability and model interpretability.

1. Advancing Building Energy Modeling with Large Language Models: Exploration and Case Studies

Liang Zhang, Assistant Professor, Associate, The University of Arizona, Tucson, AZ

2. Applications and Data Challenges of Using ML Based Method for Building Control and Fault Diagnosis

Jin Wen, Ph.D., S-B-a Member, Drexel University, PHILADELPHIA, PA

3. Forecasting Electricity Load and HVAC Zone Temperatures in Grid-Interactive Efficient Buildings Using Machine Learning

James McNeill Jr, PHD, PE, BEMP, Full Member, Edo, Seattle, WA

4. Application of Machine Learning to Assist a Moisture Durability Tool

Mikael H Salonvaara, Senior R&D Staff, Full Member, Oak Ridge National Laboratory, OAK RIDGE, TN

8:00 AM - 9:30 AM

Seminar 22 (Advanced)

Recent Radiant Heating and Cooling Research in Science and Technology for the Built Environment

Track: Hydronic Systems



Room: Water Tower A

Sponsor: Pub. & Ed. Council

Chair: Jeffrey D Spitler, PhD, PE, Fellow S-B-a Member, Oklahoma State Univ, Stillwater, OK

This session presents recent research on radiant heating and cooling published in ASHRAE's research journal, Science and Technology for the Built Environment. The topics include system performance, predictive controls, load calculations, and system design.

1. Radiant Cooling Systems: Design and Operation Factors that Impact System Performance

Atila Novoselac, PhD, Associate, University Of Texas, AUSTIN, TX

2. Radiant Cooling Systems: Methods for Load Calculation and System Design Procedure

Ardehsir Moftekhari, PhD, Student, Oklahoma State Univ, Stillwater, OK

3. Experimental Assessment and Modeling of Radiant Cooling Technologies

Omar Abdelaziz, PhD, American University of Cairo, Cairo, Egypt

4. Predictive Control of Hydronic Floor Conditioning in a Highly Glazed Building: Friend or Foe?

Sarah Brown, PhD, Carleton University, Ottawa, ON, Canada

8:00 AM - 9:30 AM

Seminar 23 (Basic)

Speed Seminar: Load Calculations in 50 Minutes!

Track: Fundamentals and Applications



Room: Great Lakes E

Sponsor: 4.1 Load Calculation Data and Procedures, YEA & Student Activities

Chair: Rachel Spitler, Full Member, Cyntergy, Tulsa, OK

A rapid-fire seminar discussing fundamentals of load calculations geared toward students and new engineers in the industry. The topics presented include Load Fundamentals, Weather Data, Building Envelope, Internal Loads and Systems and Zoning. This presentation covers the most important fundamental factors to understand and consider in performing a load calculation.

1. Fundamentals

Larry Sun, P.E., Full Member¹, Steven F Bruning, PE, LEED AP, FASHRAE, Fellow Life Member², Liam J Buckley, C. Eng., ASHRAE Member, BEMP, BEMP, S-B-a Member³, Christopher K Wilkins, PE, Full Member⁴ and James F Pegues, Full Member⁵, (1)DMG Corporation, Orange, CA, (2)Newcomb & Boyd-Retired, Atlanta, GA, (3)IES Ltd, Walnut Creek, CA, (4)RFS Engineering, LACONIA, NH, United States, (5)Carrier Corporation, Fort Lauderdale, FL

8:00 AM - 9:30 AM

Seminar 24 (Intermediate)

Thermally Driven Heat Pumps for Cooling and Heating

Track: HVAC&R Systems and Equipment



Room: Water Tower B

Sponsor: 8.3 Absorption and Heat Operated Machines, 1.10 Combined Heat and Power Systems

Chair: William A Ryan, PhD, Fellow S-B-a Member, University of Illinois at Chicago, CHICAGO, IL

This seminar covers information on any absorption heat pump or other heat-operated systems used for cooling and heating, hot water, space conditioning or industrial applications, and how these technologies can assist improve overall efficiency, promote decarbonization and reduce peak electric loads. Systems may be either direct-fired, use waste heat or when used as part of a combined heat and power system.

1. Gas Absorption Heat Pump Role in Decarbonization: A Case Study on Domestic Hot Water Heating for a Multi-Residential Building in Toronto

Farzin M Rad, PhD, P.Eng, Full Member, Enbridge Gas Inc., Vaughan, ND, Canada

2. Prestigious Energy Performance Co-generation via Solar Assisted Absorption Cooling

Marija S Todorovic, PhD, Fellow Member, University of Belgrade, Belgrade, Serbia

3. Hybrid Heat-Driven Ejector Cooling System with Increased Operating Range Using Environmentally Friendly R290

Stefan Elbel, Full Member, Technische Universität Berlin, Germany, Berlin, Germany

Monday, January 22, 9:45 AM - 10:45 AM

Paper Session 1 (Intermediate)

Virtual Paper Session

Track: Artificial Intelligence

Room: Zoom

Chair: Money Khanna

1. Protocols for Improving Air Distribution, Thermal Comfort and Energy Efficiency in Open-Plan Offices Using Micro-Zonal Occupant Centric Control (CH-24-C047)

Jeslu Celine Jacob, Research Scholar, Student, Debapratim Pandit, Associate Professor and Joy Sen, Professor, IIT Kharagpur, Kharagpur, India

2. Whole Building Calibrated Simulation of Energy Performance Towards Net Zero: Case Study of a Medium-Sized Hotel (CH-24-C058)

Benedict Tertsea Shinku, Engr., Brunel University London, Uxbridge/ Middlesex, United Kingdom

3. An Investigation into the Capability of Inverse Model-Based Algorithms for Monitoring Building Envelope Performance (CH-24-C059)

Darwish Akram Darwazeh, PhD Environmental Engineering¹, Saptak Dutta¹, Burak Gunay, Ph.D, P.Eng.², Scott Shillinglaw¹, Brodie William Hobson, Student² and Farzeen Rizvi¹, (1)National Research Council Canada, Ottawa, ON, Canada, (2)Carleton University, Ottawa, ON, Canada

4. Integration of a Solar Water Heating System with Encapsulated Phase Change Material Storage for Enhanced Energy Efficiency in Domestic Hot Water Systems (CH-24-C114)

Sohrab Saadat Pour, Student, Mahdi Momeni, Research Assistant, Amirhossein Khayyaminejad, Student Member and Amir Fartaj, Professor, Member, University of Windsor, Windsor, ON, Canada

9:45 AM - 10:45 AM

Panel 6 (Intermediate)

Tall Building Design: An Owner's/Operator's Perspective

Track: Tall Building Design

Room: Great Lakes B

Sponsor: 9.12 Tall Buildings

Chair: Francis J Kohout, Director of Engineering, Full Member, Cyclone Energy Group, CHICAGO, IL

The panel will consist of four people who own, operate, or have to perform their professional duties in tall buildings. They will share their experiences when managing or interacting with a tall building's HVAC and plumbing systems. Their discussions will focus on design elements that have long-term operational impacts on these systems.

The intended outcome of this panel is to provide feedback to the tall building design community, feedback which they would not receive during the typical tall building design and construction process.

1. Commercial Tall Building Operator

Barbara Hickey, EQ Office, Chicago, IL

2. Residential Tall Building Manager

Amy Eickhoff, First Service residential, Chicago, IL

3. Residential Tall Building Developer/Owner

Frank Soldano, Related Midwest, Chicago, IL

4. Fire District #1 Chief

James McDonough, Chicago Fire Department, Chicago, IL

9:45 AM - 10:45 AM

Paper Session 12

Micro-Zone and Personalized Ventilation Strategies

Track: Ventilation, Indoor Air Quality and Air Distribution Systems

Room: Great Lakes F

Chair: Jaya Mukhopadhyay, Montana State University, Bozeman, MT

In the study of the first paper, it establishes the effectiveness of protocols for micro-zonal occupant centric controls and gives a systematic method by which they can be applied to real buildings with open-plan offices. The second paper presents a novel low-momentum personalized ventilation system with a protective role against airborne pathogens. Numerical simulations, supported by non-intrusive experimental measurements, were used to demonstrate the effectiveness of the proposed system.

1. Assessing the Impact of Poor-Performing Homes on Indoor Air Quality Pre- and Post-Energy Retrofits in Low-Income Populations (CH-24-C044)

Sara Al Humidi and Tianyuan LI, Associate, The University of Waterloo, Waterloo, ON, Canada

2. Advanced Personalized Ventilation Strategies in Aircraft Cabins for Enhanced Protection Against Airborne Pathogens (CH-24-C048)

Paul Danca¹, Matei Razvan Georgescu¹, Florin Bode¹, Razvan Calota¹, Costin Ioan Cosoiu² and Ilinca Nastase, Eng, Full Member¹, (1)CAMBI Research Center, Technical University of Civil Engineering Bucharest, Bucharest, Romania, (2)Aerodynamics and Wind Engineering Laboratory "Constantin Iamandi", Technical University of Civil Engineering Bucharest, Bucharest, Romania

9:45 AM - 10:45 AM

Paper Session 13

Building Greenhouse Gas Emissions and Gaseous Contaminants

Track: Ventilation, Indoor Air Quality and Air Distribution Systems



Room: Great Lakes G

Sponsor: 9.10 Laboratory Systems

Chair: Matthew Davy, Full Member, Arup, London, MA, United Kingdom

The imperative to understand and address building-related greenhouse gas (GHG) emissions and gaseous contaminants has gained significance in light of climate change and indoor air quality concerns. This session includes the estimation of GHG considering building location and grid mix on a sub-hourly basis associated with building operations and assessing bio-aerosol transfer in semi-permeable and gaseous contaminants within total energy recovery wheels. This session illuminates recent efforts within the ASHRAE community to formulate guidelines and practices for establishing a contaminant-free indoor environment.

1. From Energy Savings to GHG Emissions: A Temporally Aligned Approach for Building Operations (CH-24-C049)

Max St-Jacques, PEng, Associate¹, Brodie William Hobson, Student², Andre Markus, PhD Candidate, Student², Burak Gunay, Associate², William T O'Brien, PhD, Associate² and Scott Bucking, Fellow ASHRAE², (1)Carleton University, OTTAWA, ON, Canada, (2)Carleton University, Ottawa, ON, Canada

2. Study of Bio-Aerosol Transfer in Semi-Permeable Membranes (CH-24-C050)

Tejvir Singh Binopal, Student, Pezhman Zolfaghari, Brooke Thompson, Melanie Fauchoux, PhD, Full Member, Albin Joseph, Carey J Simonson, Fellow S-B-a Member, Shelley Kirychuk and Hadi Ramin Sr., Eng, Associate, University of Saskatchewan, Saskatoon, SK, Canada

3. Test Method to Evaluate Cross-Contamination of Gaseous Contaminants within Total Energy Recovery Wheels (RP-1780) (CH-24-C051)

Carey J Simonson, Fellow S-B-a Member¹ and Easwaran N Krishnan, Associate R&D Staff, Associate², (1)University of Saskatchewan, Saskatoon, SK, Canada, (2)Oak Ridge National Laboratory, OAK RIDGE, TN

9:45 AM - 10:45 AM

Seminar 25 (Intermediate)

Grid-Interactive Buildings for a Decarbonized World

Track: Decarbonization and Climate Change



Room: Water Tower B

Sponsor: 7.6 Building Energy Performance, 7.5 Smart Building Systems

Chair: Scott P West, P.E., LEED AP BD+C, Full Member, Summit Consultants, Fort Worth, TX

Grid-interactive buildings are at the forefront of decarbonization in the built environment. Advanced controls can be employed to optimize efficiency and carbon savings between energy demand and supply, taking into account real-time effects. Grid-interactive buildings take full advantage of distributed energy resources and ensure buildings and grid are optimized as a system. Join us for an introduction to the new ASHRAE Grid-Interactive Buildings for Decarbonization: Design and Operation Resource Guide as well as some of the project case studies that helped inform the development of the guide.

1. Grid Interactive Buildings for Decarbonization Guide Overview

Katherine G Hammack, CEM, LEED-AP, Fellow Member, GCBI

2. Grid-Interactive Buildings in the Wild

Scott P Hackel, PE, LEED AP, Full Member, Slipstream, Madison, WI

3. So, You Want a Grid Interactive Building...Now What? An Overview of Key Targets, Metrics and Specs

Alexi Miller, P.E., Full Member, New Buildings Institute, PORTLAND, OR

9:45 AM - 10:45 AM

Seminar 26 (Intermediate)

LIVESTREAM: Advancements in Heat Exchanger Devices: Exploring Cutting-Edge Innovative Surfaces for Heat Transfer Enhancement

Track: HVAC&R Systems and Equipment



Room: Great Lakes A

Sponsor: 8.5 Liquid-to-Refrigerant Heat Exchangers, TC 1.3

Chair: Kashif Nawaz, PhD, Associate, Oak Ridge National Lab, Oak Ridge, TN

This seminar focuses on recent innovations in heat transfer enhancement and their result in continuous improvement of higher energy efficient equipment. First study demonstrates the application of Adjoints and Parametric Curves, for inventing new heat transfer surfaces. Second study explores the utilization of diffusion bonded heat exchangers with mini-channels. The research examines the impact of phase distribution on heat transfer performance, utilizing various rib configurations. The last study focuses on comparing the performance of two types of heat exchangers: the layered microchannel heat exchanger and the plate heat exchanger.

1. Shape and Topology Optimized Heat Exchangers Using Adjoint Methods

Vikrant C Aute, Ph.D., Fellow Member, University of Maryland, COLLEGE PARK, MD

2. Boiling Flow Analysis in Diffusion Bonded Heat Exchanger Based on Flow Visualization Using Neutron Radiography

Hitoshi Asano, Dr., Kobe University, Kobe, Japan

3. Heat Transfer Performance of Layered Microchannel Heat Exchangers

Norihiro Inoue, Dr., Full Member, Tokyo University of Marine Science and Technology, Tokyo, Japan

9:45 AM - 10:45 AM

Seminar 27 (Basic)

MEP Coordination and the Commissioning Process: Extraordinary Success or Horrible Failure Is Determined by Proactive Planning and Teamwork

Track: Fundamentals and Applications



Room: Water Tower A

Sponsor: 7.9 Building Commissioning, 7.7 Testing and Balancing

Chair: Jeremy White, PE, CxA, Full Member, Engineered Air Balance Co., Inc., Richardson, TX

As the building industry moves toward new technologies and more complex control strategies, the Commissioning Process (Cx) as defined by ASHRAE is critical to the energy performance and operational goals of the facility. The success of Cx depends on proactive planning between the Cx Provider and the Contractor's team. This seminar will demonstrate how a general contractor and Cx provider should work together to ensure a successful (and profitable) project delivery.

1. The Commissioning Process: What the Contractor Needs to Know

Justin F Garner, PE, CxA, Full Member¹ and **Mark McGlathery, Full Member²**, (1)Engineered Air Balance Company Inc, Spring, TX, (2)McCarthy Holdings, Denver, CO

9:45 AM - 10:45 AM

Forum 2

Data Communications in Critical Environments

Track: Labs, Clean Spaces and Mission Critical Facilities

Room: Great Lakes C

Sponsor: 9.10 Laboratory Systems

Chair: Christine Reinders-Caron, Full Member, Iowa State University, Des Moines, IA

Data is continually exchanged between controllers and other IoT devices in buildings. How are you seeing this data exchange being managed in critical environments? What are suggested best practices solutions for critical environment spaces? What lessons have you learned on projects that should be shared in the industry as they apply to laboratories, healthcare facilities, data centers, clean rooms, and other mission critical facilities? Join this forum for an open discussion regarding data communications in critical environments.

9:45 AM - 10:45 AM

Forum 3

Pulling back the Curtain on DEI

Track: Fundamentals and Applications

Room: Great Lakes E

Chair: Jonathan Smith, Siemens, Lenexa, KS

"Pulling back the Curtain on DEI" is an invitation for "believers" and "non-believers" to bring their tough questions and an opportunity to learn about the positive impact DEI has on organizations, such as ASHRAE.

1. Pulling Back the Curtain on DEI

Mindy Gulati, Fundamental Advisory

Monday, January 22, 11:00 AM - 12:00 PM

Panel 7 (Intermediate)

Let's Talk About SCOPE: Simplifying Construction and Operation with Proficient Engineering

Track: Fundamentals and Applications

Room: Great Lakes B

Chair: Coral Winona Pais, P.E., Full Member, DLR Group, OMAHA, NE

Three decades ago we could build a building with perhaps a third of the drawings that a building today is constructed with. Has an increase in the amount of construction documentation aided or hindered our project delivery methods? Our panelists with experience in design, construction and building operations will share insights on drawings and specifications that are critical in project delivery, techniques and tools that have been most beneficial during turnover and design and construction processes that can keep operations smart and simple.

1. Design Engineer

Jason A Majerus, P.E., Associate, Westlake Reed Leskosky, Cleveland, OH

2. Mechanical Contractor

Thomas E Martin, T. H. Martin

3. Facility Manager

Tyler Laseter, Case Western Reserve University, Cleveland, OH

4. Owners Representative, Construction Manager

Michael Pisanelli, &estimate, Cleveland, OH

11:00 AM - 12:00 PM

Paper Session 14

Heat Sinks, Thermochemical Energy Storage and Thermal Energy System

Track: HVAC&R Systems and Equipment



Room: Great Lakes F

Chair: Ammar Bahman, Assistant Professor, Full Member, Kuwait University, Safat, Kuwait

Using swimming pools as heat sinks for air conditioner waste heat has been estimated to reduce air conditioner energy use, and a paper describes the results from a demonstration of a retrofit technology for allowing air conditioner waste heat to be rejected to a swimming pool. Thermochemical energy storage utilizing salt hydrates is a novel method to harness renewable and low-grade thermal energy, and a paper makes the case that the deployment of this technology could be an economically and environmentally advantageous venture. Finally, a paper researches concludes that aquifer thermal energy storage triplet systems can be feasible.

1. Swimming Pools as Heat Sinks for Air Conditioners (CH-24-C052)

Curtis Harrington, PE, Student, UC Davis Western Cooling Efficiency Center, Davis, CA

2. Application of Salt Hydrate-Based Thermochemical Energy Storage in Buildings (CH-24-C053)

Xuelei Xiao, Student, North Dakota State University, FARGO, ND

3. Avoiding Electricity Grid Congestion and Saving Energy by Using a Triple Well Aquifer Thermal Energy System with No Heat Pump (CH-24-C054)

Raymon Wasman, MSc¹, Rick Kramer, MSc, Ph.D.², Marco Maas³ and Wim Maassen, Full Member³, (1)Eindhoven University of Technology, Rotterdam, Netherlands, (2)Eindhoven University of Technology, Eindhoven, Netherlands, (3)Royal HaskoningDHV, Rotterdam, Netherlands

11:00 AM - 12:00 PM

Paper Session 15

Gas, Electric and Hybrid Heat Pump Research

Track: HVAC&R Systems and Equipment

Room: Great Lakes G

Chair: Joy Eileen Altwies, PhD, Full Member, University of Wisconsin-Madison, Madison, WI

A paper details a heat-pump-driven liquid-desiccant air-conditioning system, which integrates the liquid-desiccant system with heat pumps capable of controlling desiccant-solution as well as air temperatures. Another paper compares limited lab-tested rated performance data to measured field datasets from multiple VRF installations and to generate curve fits that can be used to refine current VRF models. The third paper explores the sizing, design and economics of a novel hybrid boiler and chiller plant with an integrated reversible GHP array with the goals of reducing peak electric demand charges in summer and to generate gas therm savings in winter.

1. Field Study of a Heat-Pump-Driven Liquid-Desiccant Air-Conditioning System Applied in a Public Building with High Latent Load (CH-24-C055)

Jae-Hee Lee, Student and Jae-Weon Jeong, Member, Hanyang University, Seoul, Korea, Republic of (South)

2. Performance Validation and Curve Fit Generation of Natural Gas and Electric Heat Pump VRF Systems (CH-24-C056)

Ramanathan Dharmarajan, Principal Engineer, Associate, Patricia Rowley, R&D Manager, Jason Stein, Engineer, Associate, Abinash Ravi, Principal Engineer, Associate Member and Shawn Scott, Senior Engineer, GTI Energy, Des Plaines, IL

3. Design and Evaluation of a Commercial Hybrid Heat Pump Plant for Therms Savings and Peak Electric Demand Management (CH-24-C057)

Abinash Ravi, P.E., Associate, Arjun Thirumaran, Associate and Jason Stein, Engineer, Associate, GTI Energy, Des Plaines, IL

11:00 AM - 12:00 PM

Seminar 28 (Intermediate)

Cutting-Edge Japanese Technologies on Hydronic System: SHASE Annual Award Winners

Track: Hydronic Systems



Room: Water Tower A

Chair: Ryoza Ooka, PhD, Fellow Member, IIS University of Tokyo, Tokyo, Japan

Buildings consume a significant amount water and thermal energy, making the effective use of local renewable energy such as groundwater for HVAC systems essential. In this seminar, methodologies applied to two office buildings located in different areas are presented. Both buildings applied a system capable of using all the heat from groundwater as precool/preheat water for outdoor air conditioners, chilled water for radiant panel or underfloor air distribution systems, and heat source water for heat pumps. These effective uses of renewable energy enable the reduction of energy consumption compared to a typical office building.

1. Heating and Cooling Systems Combining Three-Stage Cascade for Maximum Use of Groundwater Heat

Koki Toyomura, Associate, Associate, NIKKEN SEKKEI LTD, Osaka, Japan

2. Planning of an Air-Conditioning System with the Direct Use of Abundant Groundwater Heat in a Medium-Sized Office Building

Takuma Takeshima, SHIMIZU CORPORATION, Nagoya, Japan

11:00 AM - 12:00 PM

Seminar 29 (Advanced)

Does Solar and/or Wind Energy Have a Role in Large and Tall Building Systems?

Track: Tall Building Design



Room: Great Lakes C

Sponsor: 9.1 Large Building Air-Conditioning Systems, 9.12 Tall Buildings

Chair: Dennis J Wessel, PE, Fellow Life Member, Retired, Hudson, OH

Tall buildings are prevalent in our society. With our future trending toward Net Zero energy, how can designs incorporate sufficient renewable energy to accommodate this requirement? Roof areas in tall buildings are a very low percentage of the overall floor area.

Title 24 requires that 35% of roof contain solar panels. This leaves little tall building roof area for HVAC equipment for a limited energy benefit.

Some countries require that buildings over 80 stories have 2-1/2% of total energy consumption from renewable sources. With limited onsite generation capability, will this requirement dictate that owners construct a renewable energy farm offsite?

1. On-Site and Off-Site Renewable Energy Opportunities for Large and Tall Buildings

Tyler Jensen, PE, Associate, Environmental Systems Design, Inc., Chicago, IL

2. Does Solar and/or Wind Energy Have a Role in Large and Tall Building Systems?

Marzia Sedino, PE, Associate, SOM, Chicago, IL

11:00 AM - 12:00 PM

Seminar 30 (Intermediate)

LIVESTREAM: Laboratory Superhero: The Critical Plan to Save

Track: Labs, Clean Spaces and Mission Critical Facilities



Room: Great Lakes A

Sponsor: 9.10 Laboratory Systems

Chair: Kelley P Cramm, P.E., Life Member, Henderson Engineers, Overland Park, KS

If there is a significant cost on your energy bill, chances are the culprit is a laboratory. Luckily, there is a plan capable of combating laboratory energy loss using four simple steps: Plan, Assess, Optimize and Manage. This session explains the Smart Labs Toolkit, a systematic process that helps laboratory owners and operators cost-effectively achieve safe, efficient and

sustainable laboratories. The presentation will highlight the Laboratory Ventilation Management Program (LVMP) template and how it optimizes energy use within high performance laboratories. With Smart Labs, you could become the next superhero saving massive amounts of energy in your laboratories!

1. Transforming Your Building into a High Performance Building

Rachel L Romero, Full Member, NREL, LAKEWOOD, CO, United States

2. Optimize Your Laboratory Ventilation with the Laboratory Ventilation Management Plan

Danika Ratnapradipa, Student, University of Nebraska - Omaha, Omaha, NE

11:00 AM - 12:00 PM

Seminar 31 (Intermediate)

Zero Emission Buildings: Rolling Out the Revised Energy Performance Buildings Directive in Europe

Track: Decarbonization and Climate Change



Room: Great Lakes E

Sponsor: 2.8 Building Environmental Impacts and Sustainability, GTIC

Chair: Jaap Hogeling, MSc, Fellow Life Member, REHVA, Brussels, Belgium

In Europe, the EPBD will direct the national regulating authorities to set-up requirements in the building regulations to achieve next to very low primary energy use a decarbonized building stock by 2050. These policy measures will be rolled out step by step where the embodied carbon will gradually be taken in account as well. This session addresses issues like primary energy calculation, zero emission building requirements, life cycle global warming potential as well potential technical solutions.

1. Building Live Cycle Global Warming Potential: New Indicator Required By the Revised EPBD

Livio Mazzarella, Prof politecnica Milano, Politecnico Milano, Milano, Italy

2. Primary Energy Calculation and New Zero Emission Building Requirements in the EPBD

Jarek Kurnitski, Tallinn University of Technology, Tallinn, Estonia

3. Heat Pumps: A High Potential Solution to Decrease Operational CO₂ Emissions in Buildings

Catalin IOAN Lungu, PhD, BEAP, BEMP and HBPD, Technical University of Civil Engineering Bucharest, Bucharest, Romania

11:00 AM - 12:00 PM

Forum 4

Why Do We have Chronic Thermal Comfort Illiteracy in Architecture and Engineering?

Track: Comfort, Indoor Environmental Quality and Energy Efficiency

Room: Water Tower B

Sponsor: 2.1 Physiology and Human Environment, SSPC 55 Thermal Environmental Conditions for Human Occupancy.

Chair: Robert Bean, Indoor Climate Consultants Inc., Chestermere, AB, Canada

Based on 17 years of polling design course participants, less than 1% of professionals can perform a compliance check to ASHRAE Standard 55 Thermal Environmental Conditions for Human Occupancy. The developed world would not tolerate such low comprehension in any other profession serving society. This forum invites all design practitioners to manufacturers to code officials to participate in a discussion on the barriers of using one of ASHRAE's most powerful Standards. Proper application of its knowledge strongly influences energy preservation, conservation and enables energy and exergy efficiency.

Monday, January 22, 12:15 PM - 2:00 PM

Special Session (Basic)

President's Lunch

Room: Grand Horizon DEFG

2023-2024 ASHRAE President Ginger Scoggins presents the Society's theme in her Presidential Address. This plated-lunch event includes recognition of RP and other special donors.

Monday, January 22, 2:15 PM - 2:45 PM

Sponsor Tech Talks (Basic)

Engineering a Greener Future: Sustainable HVAC Solutions for Existing Buildings

Track: HVAC&R Systems and Equipment

Room: Water Tower A

Decarbonizing commercial heating systems in existing buildings presents one of the largest opportunities to achieve net zero goals. Fortunately, massive budgets are not always required in order to achieve meaningful solutions on the path to sustainability. Join us for an insightful conversation at the ASHRAE Tech Talk: "Engineering a Greener Future: Sustainable HVAC Solutions for Existing Buildings."

Presented by: Johnson Controls

Engineering a Greener Future: Sustainable HVAC Solutions for Existing Buildings

Jon McCreary, Johnson Controls

Engineering a Greener Future: Sustainable HVAC Solutions for Existing Buildings

Rob Tanner, Johnson Controls

2:15 PM - 2:45 PM

Sponsor Tech Talks (Basic)

Building Electrification with Geothermal Heat Pumps

Track: HVAC&R Controls

Room: Water Tower B

Presented by: Cold Climate Group

Building Electrification with Geothermal

Walter Kittledge, Cold Climate Group

2:15 PM - 3:45 PM

Seminar 32 (Intermediate)

Paving the Way for Zero Codes for Residential and Commercial Buildings

Track: Decarbonization and Climate Change



Room: Great Lakes B

Sponsor: 7.6 Building Energy Performance

Chair: Christopher Perry, Engineer, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy, DC

A large number of jurisdictions are starting to adopt zero energy or zero carbon goals, however, with less than 5% of new construction being zero-carbon ready, a range of technologies, regulations and policies are needed to meet these targets. Building energy codes and related policies are being redefined to support additional metrics, account for renewables, and encourage decarbonization. Traditional compliance approaches are being replaced by performance-based approaches. Building performance standards are being defined for measuring and improving performance of existing buildings. This session introduces several strategies that are being defined and adopted to ease the transition into zero codes.

1. Paving the Way for Zero Codes through Performance-Based Approaches

Supriya Goel, Associate, PNNL, RICHLAND, WA, United States

2. Closing the Gap for Zero Energy Performance

Ellen M Franconi, PhD, Full Member, Pacific Northwest National Laboratory, Richland, OR

3. Model Zero Code for Residential and Commercial Buildings

Michael Tillou, Full Member, Pacific Northwest National Lab, RICHLAND, WA

4. Aligning Building Performance Standards with New Construction Codes

Kimberly Cheslak, Full Member, Pacific Northwest National Lab, RICHLAND, WA

Monday, January 22, 3:00 PM - 3:30 PM

Sponsor Tech Talks (Basic)

Smart Buildings of Today & Tomorrow

Track: Comfort, Indoor Environmental Quality and Energy Efficiency

Room: Water Tower A

Explore the cutting edge of digital technology and gain insights into the current state, and future trajectory, of smart buildings through live demonstrations showcasing capabilities in key areas like energy efficiency, wellbeing, compliance, operational security and equipment optimization. Speakers will delve into real-life case studies that highlight the transformative benefits of digital solution implementation in buildings. Meet local team members who serve as collaborative partners throughout the entire solution life cycle, from assessment to project development, execution, and ongoing service.

Presented by: Johnson Controls

Monday, January 22, 3:15 PM - 4:45 PM

Debate 1 (Intermediate)

College of Fellows Debate: Using AI is Cheating!

Track: *Artificial Intelligence*

Room: *Great Lakes A*

Sponsor: 1.7 Business, Management & General Legal Education, 7.1 Integrated Building Design

Chair: Lynndy Hedgcoth, Associate, Affiliated Engineers, Inc., Seattle, WA, Mitchell Swann, P.E., Life Member, Resolution Management Consultants, Inc., Philadelphia, PA, Martin Roy, P.Eng, Leed Fellow, Martin Roy et associates Quebec, Quebec, QC, Canada, Mina Agarabi, Full Member, Agarabi Engineering, PLLC, Brooklyn, NY and Filza H Walters, Fellow S-B-a Member, Texas A&M University, COLLEGE STATION, TX

Will AI transform the HVAC industry? Some say that AI can improve energy efficiency, reduce operating costs and improve occupant comfort. Predictive analytics can optimize system performance, diagnose and troubleshoot problems and provide real-time support to technicians. Others contend that AI is not sophisticated enough to provide reliable results; the cost is prohibitive, and produce wonderfully worded, but completely wrong answers that can lead to serious problems. Is AI an augmentation of professional skills or an abdication of leadership in the design process? Come to this debate and be heard (and find out if AI wrote the abstract!)

College of Fellows Debate: Using AI is Cheating!

3:15 PM - 4:45 PM

Paper Session 16

Advancing Building Performance Technologies (Poster)

Track: *Decarbonization and Climate Change*



Room: *Great Lakes F*

Chair: Yunho Hwang, PhD, Fellow Member, University of Maryland, College Park, MD

Discover breakthroughs in building performance and energy systems. Studies include closing the Performance Gap in a hotel for Net Zero goals, using inverse models for continuous envelope monitoring, optimizing solar power self-sufficiency with varied building parameters, developing advanced frameworks for energy storage in large-scale offices, and evaluating cooling tower efficiency under future climate change. These insights propel sustainable building practices and enhance energy efficiency.

1. Dynamic Study of the Influence of Building Parameters on the Self-Consumption of Solar Power (CH-24-C060)

Wolf Bracke¹, Luca Maton¹, Eline Himpe¹, Klaas De Jonge¹ and Jelle Laverge¹, (1)Ghent University, Ghent, Belgium

2. Enhancing Building Energy Efficiency through Advanced Sizing and Dispatch Methods for Energy Storage (CH-24-C061)

Min Gyung Yu, PH.D¹, Bowen Huang¹, Karthikeya Devaprasad, Associate¹, Xu Ma¹, Fredericka Brown¹ and Di Wu¹, (1)Pacific Northwest National Lab, Richland, WA

3. Research on the Calculation of Cooling Tower Required Values Considering Future Climate Change (CH-24-C062)

Ryota Miyamoto, Eng, Student and Masaya Nishikwa, PhD, Associate, Tokyo Denki University, Tokyo, Japan

3:15 PM - 4:45 PM

Paper Session 17

Fault Diagnosis of Chillers and Configuration Optimization for TES (Poster)

Track: *Fundamentals and Applications*



Room: *Great Lakes G*

Chair: Samir R Traboulsi, P.Eng., Fellow Life Member, Thermotrade/Ranec, Beirut, Lebanon

The first paper utilizes the benchmark chiller data collected by ASHRAE 1043-RP and investigates machine learning and deep learning approaches for fault detection in refrigeration systems. This study found that deep learning methods, such as the Long Short-Term Memory, produce better results if using the complete dataset for training. The second paper provides a comprehensive review of configuration optimization in thermal energy systems, covering various aspects from problem formulation to algorithm selection and technical implementation.

1. Fault Diagnosis of Chillers Using Dimensionality Reduction Methods (CH-24-C063)

Swarnali Mukhopadhyay, Student, Yixin Huangfu, Postdoctoral Researcher and Saeid Habibi, mcmaster university, Hamilton, ON, Canada

2. A Review of Configuration Optimization for Thermal Energy Systems (CH-24-C064)

Lei Gao, Postdoc, Associate¹, Xiaoli Liu, Associate² and Yunho Hwang, PhD, Fellow Member¹, (1)University of Maryland, College Park, MD, (2)Oak Ridge National Laboratory, Oak Ridge, TN

3. Parametric Translation of Surrogate Building Energy Models into Thermal RC Networks (CH-24-C122)

Blessing Onyeché Ayegba, Student, Student, Seyed Matin Abtahi, Ph.D Student, Student Member ASHRAE, Student and **Andreas K Athienitis, Ph.D., P.E., Fellow Life Member**, Concordia University, Montreal, QC, Canada

4. Understanding Housing Challenges in Rural Alaskan Communities (CH-24-C101)

Christiana Marie Kiesling, Student¹, Patricia Guillaute, Student¹ and Kristen Ceti^{1,3}, (1)Michigan State University, East Lansing, MI

3:15 PM - 4:45 PM

Seminar (Intermediate)

MEP 2040: A Recap of 2023 Q4 Forum

Track: Decarbonization and Climate Change

Room: Great Lakes E

Chair: Robert J Bolin, PE, Full Member, Introba, Oakland, CA

This session provides a recap of the MEP2040 Q4 Forum topics and 2023 year-in-review. Topics include summaries of the ECHO (Embodied Carbon Harmonization and Optimization) Project, the EPA Notice of Funding Opportunities for companies to develop EPDs and low-carbon building projects, and MEP2040 working group activities and progress in 2023.

MEP 2040 Presentation

Kayleigh Houde¹, **Josh Jacobs, LEED AP+ BD&C²**, **Adam McMillen³** and **Cory Duggin, Full Member⁴**, (1)BuroHappold, Los Angeles, CA, (2)WAP Sustainability, Seattle, WA, (3)IMEG, Chicago, IL, (4)TLC Engineering Solutions, Nashville, TN

Tuesday, January 23

Tuesday, January 23, 8:00 AM - 9:30 AM

Panel 8 (Intermediate)

Impacts of Standard 241 on ASHRAE's Existing Ventilation Standards

Track: Ventilation, Indoor Air Quality and Air Distribution Systems

Room: Great Lakes B

Sponsor: EHC, SSPC 62.1, SSPC170

Chair: Brendon Joseph Burley, Healthcare Practice Leader, Full Member, Burdette, Koehler, Murphy & Associates, Inc., Baltimore, MD

Speakers familiar with Standards 62.1, 62.2, and 170 will discuss their experiences with implementing Standard 241. The presentations will focus on how Standard 241 has changed the way they design and operate ventilation systems and any challenges they have encountered with implementing Standard 241. The audience will be encouraged to share their own experiences and receive feedback from the panel.

1. Standard 241 and Standard 62.1

Meghan Kara McNulty, PE, Full Member, Servidyne, ATLANTA, GA

2. Standard 241 and Standard 62.2

Iain S Walker, PhD, Member, Lawrence Berkeley Laboratory, Berkeley, CA

3. Standard 241 and Standard 170

Jonathan Flannery

8:00 AM - 9:30 AM

Paper Session 18

Machine Learning and Other Control Systems

Track: HVAC&R Controls



Room: Great Lakes F

Chair: Vikrant C Aute, Ph.D., Fellow Member, University of Maryland, COLLEGE PARK, MD

This session explores HVAC Machine Learning Control systems; classifying a peak-demand event in a peak-load pricing scenario; the implementation strategy of AI in chiller plant optimization; a way to evaluate the sensitivity of models to control signals; and defining a data-driven procedure for building modelling.

1. Interpretable Machine Learning for Supervisory Control in Building Energy Systems (CH-24-C065)

Liang Zhang, Assistant Professor, Associate, The University of Arizona, Tucson, AZ

2. A Closed-Feedback Loop Approach for Active Monitoring of Peak-Demand Events and Automatic Response (CH-24-C066)

Andre Markus, PhD Candidate, Student¹, Brodie William Hobson, Student¹, Jayson F Bursill, Ph.D, P.Eng., Full Member² and Burak Gunay, Ph.D, P.Eng.¹, (1)Carleton University, Ottawa, ON, Canada, (2)Delta Controls Inc., Surrey, BC, Canada

3. Chiller Energy Optimization Using Artificial Intelligence: Experience in Hong Kong (CH-24-C067)

Lai K Fai, Full Member¹, Kin Pong Li¹, Victor Tat Tong Wong¹ and Kin Fai Yow¹, (1)Electrical and Mechanical Services Department, Hong Kong

4. Investigations on the Influence of Model Accuracy in Deep Reinforcement Learning Control for HVAC Applications (CH-24-C068)

Mingyue Guo, Student¹, Yangyang Fu, Ph.D., Associate¹, Mingzhe Liu, Ph.D., Student¹ and Zheng O'Neill, Ph.D., P.E., Fellow Member¹, (1)Texas A&M University, College Station, TX

5. Model Order Reduction Based on Clustering Approach for Energy Aggregators in Demand Response (CH-24-C069)

Andrea Petrucci, Ph.D. Student¹, Andreas K Athienitis, Ph.D., P.E., Fellow Life Member¹, Annamaria Buonomano, Ph.D.² and Benoit Delcroix, Ph.D.³, (1)Concordia University, Montreal, QC, Canada, (2)University of Naples - Federico II, Naples, Italy, (3)Hydro-Québec Research Centre, Laboratoire des Technologies de l'Energie (LTE), Shawinigan, QC, Canada

8:00 AM - 9:30 AM

Paper Session 19

Building System Monitoring and Optimization: From Fault Detection to Advanced Sensor Technologies

Track: HVAC&R Controls



Room: Great Lakes G

Chair: Sonya M Pouncy, CEM, LEED AP, Full Member, Building Vitals, Detroit, MI

The first presentation presents a framework for Automated Fault Detection in light commercial buildings. The second presentation examines a shift in chiller component model calibration through Bayesian principles by introducing a novel approach leveraging limited operational data and manufacturer's catalog data. The third presentation unveils data management and visualization tools for achieving Building Energy Management and Building Automation System interoperability, enhancing control and management of real-world built environments. The last presentation is an exploration of an advanced frost sensor for HVAC applications, revolutionizing defrosting techniques with a smart sensor using capacitive sensing.

1. Real-Time, Demand-Driven HVAC and Lighting Control Using Computer Vision-Based Detection of Internal and Solar Gains (CH-24-C124)

Dongjun Mah, Student¹, Athanasios Tzempelikos, PhD, Full Member¹ and Kevin J. Kircher¹, (1)Purdue University, W Lafayette, IN

2. A Framework for Automated Fault Detection in Light Commercial Buildings (CH-24-C070)

Milad Babadi Soltanzadeh, Student¹, Mohamed Ouf, Associate¹, Mazdak Nik-Bakht¹, Pierre Paquette³ and Steve Lupien³, (1)Concordia University, Montreal, QC, Canada, (3)Strato Automation, Montreal, QC, Canada

3. Calibration of Chiller Component Model with Limited Operational Data: The Use of Manufacturer's Catalog Data Via Bayesian Principle (CH-24-C071)

Sang woo Ham, Associate and Donghun Kim, Full Member, Lawrence Berkeley National Laboratory, Berkeley, CA

4. Data Management and Visualization Tools for BEM and BAS Interoperable Building Analysis and Control (CH-24-C072)

Jung-Ho Lewe, Ph.D., EMP¹, Hyun Woo Kim, Student¹ and Adrian Luke Mungroo, Student¹, (1)Georgia Institute of Technology, Atlanta, GA

5. Advanced Frost Sensor for HVAC Application (CH-24-C073)

Zhiming Gao, Full Member¹, Jamieson Brecht, Member¹, Philip Boudreaux¹, Nikolay Lavrik Lavrik¹, Kashif Nawaz, PhD, Associate¹, Brian A Fricke, Fellow Member¹ and Kyle R Gluesenkamp, Ph.D., Full Member¹, (1)Oak Ridge National Laboratory, Oak Ridge, TN

8:00 AM - 9:30 AM

Seminar 33 (Basic)

Defining and Creating Buildings That Truly Perform at 'Net Zero'

Track: Decarbonization and Climate Change



Room: Great Lakes C

Sponsor: 2.8 Building Environmental Impacts and Sustainability , CIBSE ASHRAE Liaison Committee PLUS ASHRAE Task Force For Building Decarbonization

Chair: Hywel Davies, BSc PhD CChem MRSC CSci MASHRAE, Member, CIBSE, Bedford, United Kingdom

The seminar explores cost-effective methods to achieve net zero buildings, drawing from real-world projects and emphasizing the stakeholders' roles in ensuring quality and environmental awareness. It unveils the design of new-build net zero commercial offices with minimal cost increase, competitive lease rates, innovative decarbonization techniques for retrofitting existing school buildings, and strategies and stages for achieving net zero hospitals in the UK. The UK's newly completed Net Zero Carbon Buildings Standard will be introduced, that offers globally applicable methods and metrics to demonstrate net zero performance effectively.

1. Moving Towards Net Zero Carbon Hospitals

Francis A Mills, Life Member, Frank Mills Consulting, Leyland, United Kingdom

2. Delivering a Net Zero Commercial Office Building

David A Clark, P.Eng., C.Eng., FCIBSE, IntPE (UK), MASHRAE, Full Member, Stantec, Waterloo, ON, Canada

3. Net Zero Delivery

Mick CA Schwedler, PE, Presidential Fellow Member, Trane, La Crosse, WI

4. Smart Retrofitting for a Net Zero Future

Tom Garrigan, BSRIA, Bracknell, United Kingdom

5. Standardising Towards a Net Zero Future

Adrian Catchpole, CEng FCIBSE, CIBSE, London, United Kingdom

8:00 AM - 9:30 AM

Seminar 34 (Intermediate)

Design of HVAC Systems for Aseptic Manufacturing Facilities

Track: Labs, Clean Spaces and Mission Critical Facilities



Room: Water Tower B

Sponsor: 9.11 Clean Spaces

Chair: Vincent A Sakraida, PE, LEED AP, Full Member, Fluor, Evansville, IN

Aseptic manufacturing can produce pharmaceutical products without microbial contamination where sterilization process is not feasible.

Aseptic facilities employ airlocks/showers and HVAC controls to prevent contaminants' intrusion, and aseptic equipment such as hoods, barriers and isolators are jointly utilized to prevent contaminations into the processing chambers. The integrated HVAC systems for both facility and containment control chambers are highly complicated and intertwined in design.

The latest GMP Annex 1 requires real-time viable particle monitoring not only in aseptic room but also inside processing chambers, and new controls applied in Risk Management, Process Analytical Technology (PAT) and Real Time Release Testing (RTRT).

1. Role of HVAC System Selection and Controls in Aseptic Manufacturing Suite

Wei Sun, P.E., Fellow Member, Engsysco Inc, ANN ARBOR, MI

2. Impact of the New GMP Annex 1 on Continuous Aseptic Manufacturing

Conor Murray, BE (Elec) MIE, Full Member, 3 Dimension, Dublin, Ireland

3. Aseptic Manufacturing Facility HVAC Design

Yusuf Ishak Bhetasiwala, Full Member, Encon Expertise Pvt. Ltd, Mumbai, India

8:00 AM - 9:30 AM

Seminar 35 (Basic)

Exhaust Energy Recovery: The Terms, Components and Control

Track: Fundamentals and Applications



Room: Water Tower A

Sponsor: 5.5 Air-to-Air Energy Recovery

Chair: Kristin Rice Sullivan, PE, Full Member, Trane Technologies

This session will introduce the basics of exhaust air energy recovery, including performance characterization, an overview of technology and exchanger types and a high-level discussion on controls. AHRI 1060 and performance metrics such as ERR and RER will be presented. The session covers all common exchanger types including rotary wheels, fixed-plate, heat pipes, and less-common exchanger types as well. Controls strategies for frost avoidance, air-side economizing, and capacity modulation will also be discussed.

1. Energy Recovery Technology and Exchanger Types

Mo Afshin Afshin, P. Eng, Member, Q-PAC Fan Systems, Elkton, FL

2. Performance Characterization of Energy Recovery Heat Exchangers

Eric Erdman, PE, Associate, Greenheck Fan Corporation, SCHOFIELD, WI

3. Overview of Exhaust Energy Recovery Control

Ronnie R Moffitt, PE, Full Member, Trane, San Juan, PR

8:00 AM - 9:30 AM

Seminar 36 (Intermediate)

LIVESTREAM: How Can Connected Communities Support U.S. DOE and ASHRAE Goals for Decarbonization and to Mitigate Climate Change?

Track: Decarbonization and Climate Change



Room: Great Lakes A

Sponsor: 7.5 Smart Building Systems

Chair: Srinivas Katipamula, Dr., Fellow Member, Pacific Northwest National Laboratory, Richland, WA

Connected Communities (CC) are a key to decarbonizing the built environment and mitigate climate change; they consist of grid-interactive buildings with flexible distributed energy resources that collectively work to support grid reliability and resiliency and to maximize building, community, and grid efficiency. The first presentation provides an overview of the U.S. Department of Energy's CC Program. The second provides an overview of the ten projects and their approaches to decarbonization. The third shows how the Spokane project will use a set of buildings served by a single substation to increase energy efficiency while simultaneously providing grid services.

1. U.S. DOE's Connected Communities: Providing Grid Services and Serving Building Occupants

Cecilia Johnson Johnson-Hayman, Ph.D., U.S. Department of Energy, Washington, DC

2. Overview of the Ten U.S. Department of Energy's Connected Community Projects

Cindy Regnier, P.E., Full Member, Lawrence Berkley National Laboratory, Berkley, CA

3. Overview of Spokane Connected Community Project

James McNeill Jr, PHD, PE, BEMP, Full Member, Edo, Seattle, WA

8:00 AM - 9:30 AM

Seminar 37 (Intermediate)

Removing the Artificial from Artificial Intelligence: Examples of Realistic and Successful Applications of AI in Controls

Track: Artificial Intelligence



Room: Great Lakes E

Sponsor: 1.4 Control Theory and Application

Chair: Elise Marie Backstrom, P.E., Full Member, Exyte U.S., Gilbert, AZ

Artificial intelligence (AI) is being used in many ways across industry. This seminar dives into real world applications of AI in Controls, including experiences, successes and lessons learned. Technologies discussed include data-driven applications of machine learning, optimizing economization for network shelters and AI algorithm application to develop machine learning of chillers.

1. Machine Learning in the Field

Jayson F Bursill, Ph.D, P.Eng., Full Member, Delta Controls Inc., Gloucester, ON, Canada

2. Case Study for AI Usage at Scale: Optimizing Economization for Wireless and Cable Network Shelters

Jake Yu, Full Member, Airsys Cooling Technologies

3. Data-Driven Modeling for Advancing Near-Optimal Control of Water-Cooled Chillers

Mohammad Heidarinejad, Ph.D., P.E., S-B-a Member, Illinois Institute of Technology, CHICAGO, IL

Tuesday, January 23, 9:00 AM - 10:15 AM

AHR Expo Session 1 (Basic)

Celebrating 30 Years of Thermal Storage in Chicagoland! Big Projects with Big Impacts: Past, Present and Future

Track: HVAC&R Systems and Equipment

Room: South S401a

Sponsor: 6.9 Thermal Storage, TC 6.2 District Cooling

Chair: Mike Filler, PE, Member, Trane Technologies, Colorado Springs, CO

Thirty years ago, we were preparing for the CFC Phaseout, Y2K and utility deregulation. Chicago responded in a big way. One team embraced trigeneration at McCormick Place with a novel chilled water storage system. Another team embraced ice and built a district cooling system in the Loop. Both are still going strong and upgrading for their next 30 years. These mega-projects influenced the surrounding areas and thermal storage projects proliferated throughout Illinois.

1. Ice Storage on Steroids: District Cooling in the Loop for 30 Years and Beyond

Geoffrey Bares, Associate, Centrio Engery, Chicago, IL

2. 30 Years of Operation of Low Temp Fluid TES at the Chicago McCormick Place District Energy System

John Andrepont, Member, Cool Solutions, Lisle, IL

3. 30 Years of Thermal Energy Storage in Illinois

Larry Henkel, McDermott, Plainfield, IL

9:00 AM - 10:30 AM

AHR Expo Session 2 (Intermediate)

Beyond the Boiler: Making It Work

Track: Hydronic Systems

Room: South S402a

Sponsor: 6.1 Hydronic and Steam Equipment and Systems

Chair: Lynndy Hedgcoth, Associate, Affiliated Engineers, Seattle, WA

This session focuses on three vital concepts to obtain an efficient steam system. The importance of boiler blowdown will be proven using real-life examples to discuss how designed systems could have improved. There will be an explanation of how waste heat is recovered using flash tanks. There will also be discussion on the benefits of vacuum condensate recovery systems.

1. Benefits of Vacuum Condensate Recovery

John Jordan Miller, Skidmore, Benton Harbor, MI

2. The Dangers of Boiler Blowdowns

Ronald George, CPD, ASSE 12080 Cert Wtr Mgmt Prof, Associate, Plumb Tech Des & Cons / PE Mag, Chicago, IL

3. Maximizing Efficiency: The Power of Flash Tanks

Patrick Adams Villaume, Full Member, Patterson-Kelley, EAST STROUDSBURG, PA

Tuesday, January 23, 9:45 AM - 10:45 AM

Panel 9 (Intermediate)

How to Overcome the Challenges Faced in Office to Lab Conversions

Track: Labs, Clean Spaces and Mission Critical Facilities

Room: Great Lakes B

Sponsor: 9.10 Laboratory Systems

Chair: Kurt Monteiro, P.Eng. LEED AP, HBDP, HFDP, Full Member, Smith and Andersen Consulting Engineering, Toronto, ON, Canada

The three panelists with a moderator will discuss how to overcome the various challenges associated with converting office space into laboratory spaces, including the increasing air changes per hour, increasing ventilation rates, improving filtration levels if required, adding laboratory exhaust systems, improving space relative pressurization control.

Panelists:

1. Dan Curley, P.Eng., P.E., LEED AP, Smith and Andersen Consulting Engineering, Toronto, ON, Canada

2. Jake Edmondston, P.E., OPMP, Member, New York University Abu Dhabi, Abu Dhabi, United Arab Emirates

9:45 AM - 10:45 AM

Paper Session 20

Assessing Building Impacts on Energy Consumption, Occupant Behavior and Thermal Resilience

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Great Lakes F

Chair: David A Yashar, PhD, Full Member, NIST, GAITHERSBURG, MD

Embark on a journey into the realm of sustainable living through three impactful presentations. The first presentation quantifies the correlation of home and office energy use with teleworking from a case study in Ontario, Canada. The second examines the impacts of building retrofitting on energy consumption and occupant behavior in residential dorms, emphasizing its multi-faceted benefits for energy conservation, comfort and urban sustainability. The third presentation explores the thermal resilience of residential buildings equipped with a thermally anisotropic building envelope connected to geothermal sources.

1. Quantifying the Impact of Teleworking on Home and Office Energy Use: A Case Study in Ontario, Canada (CH-24-C074)

Farzam Sepanta, Student, Melina Sirati and William T O'Brien, PhD, Associate, Carleton University, Ottawa, ON, Canada

2. Quantifying the Impacts of Building on Energy Consumption and Occupant Behavior: A Case Study on Residential Dorms (CH-24-C075)

Pratik Raj Pandey, Research Assistant, Student, Nina Sharifi, Ph.D. and Bing Dong, Ph.D., S-B-a Member, Syracuse University, Syracuse, NY

3. Thermal Resiliency of Residential Buildings with Thermally Anisotropic Building Envelope Connected to Geothermal Sources (CH-24-C076)

Zhenglai Shen, R&D Associate Staff, Associate¹, Som S Shrestha, Full Member¹, Daniel Saleem Howard, Student¹, Diana Hun¹, Sven Mumme³ and Bandana Kar³, (1)Oak Ridge National Laboratory, Oak Ridge, TN, (3)Department of Energy, Building Technologies Office, DC

9:45 AM - 10:45 AM

Paper Session 21

Refrigerant Leakage, Cold Climate Heat Pumps and Hybrid Solvers

Track: Fundamentals and Applications



Room: Great Lakes G

Chair: Lorenzo Cremaschi, PhD, S-B-a Member, Auburn University, Auburn University, AL

The first presentation unveils findings from an experimental study on refrigerant leakage in variable-speed rolling piston compressors, shedding light on the intricate dynamics of oil-mixture leakage flows and their impact on compressor performance. The second delves into the U.S. Department of Energy's Cold Climate Heat Pump Challenge, outlining the development, metrics, and early field observations of advanced electric heat pumps designed for cold climates. Finally, the third presentation investigates the application of two hybrid solvers for robust and accurate steady-state simulation of vapor compression cycles, presenting comparative analyses and performance evaluations against the conventional Newton solver.

1. An Experimental Study of Refrigerant Leakage in Variable Speed Rolling Piston Compressors (CH-24-C077)

Cheng-Yi Lee, Student¹, Yunho Hwang, PhD, Fellow Member¹ and Scott Shaffer³, (1)University of Maryland, College Park, MD, (3)GE Appliances, Louisville, KY

2. DOE Cold Climate Heat Pump Challenge: Development, Metrics and Early Field Observations (CH-24-C078)

Vrushali Mendon, Associate¹, **Jim Young²**, Julia Rotondo¹, Kevin Keene³, Sam Rosenberg³, Ali Akber Kazmi² and **Payam Delgoshaei⁴**, (1)Pacific Northwest National Laboratory, Richland, WA, (2)Guidehouse, Inc., Burlington, MA, (3)Pacific Northwest National Laboratory, Arlington, VA, (4)U.S. Department of Energy, Oak Ridge, TN

3. Investigation on Two Hybrid Solvers for Robust and Accurate Steady-State Simulation of Vapor Compression Cycles (CH-24-C079)

Abdulmumin Olamilekan Olaoke, Student¹, Baojie Mu² and Yaoyu Li, PhD, Full Member¹, (1)University of Texas at Dallas, RICHARDSON, TX, (2)Rheem Manufacturing Company, Lewisville, TX

9:45 AM - 10:45 AM

Seminar 38 (Basic)

Leveraging the Value of Your Energy Model

Track: Fundamentals and Applications



Room: Water Tower A

Sponsor: 7.2 HVAC&R Construction & Design Build Technologies , Young Engineers in ASHRAE

Chair: Heather R Schopplein, PE, DBIA, CM-LEAN, Full Member, UMEC, Santee, CA

An energy model is neither a Revit button nor a “one-and-done” design activity. Rather, energy models allow designers to go beyond aesthetics and see options through the lens of energy performance. We identify four phases where models improve energy performance and provide compelling evidence that energy models quantify the performance of ideas that designers are interested in exploring. We present a scalable energy model workflow, and share insights where models pay for themselves, including recent changes to the 179D energy efficiency tax deduction. And finally, we'll discuss the most impactful communication strategies to describe energy use to all team members.

1. Leveraging the Value of Your Energy Model: A Field Guide from Conceptual Design through Operation

Amanda E Bogner, PE, BEMP, Full Member, Energy Studio Inc, Omaha, NE

2. How to Talk about Energy

Jessica J Renner, PE, BEMP, Full Member, Energy Studio, Inc, Omaha, NE

9:45 AM - 10:45 AM

Seminar 39 (Intermediate)

LIVESTREAM: Indoor Air Quality, Automation and Artificial Intelligence in Tall Buildings

Track: Tall Building Design



Room: Great Lakes A

Sponsor: 9.12 Tall Buildings, 7.5 Smart Building Systems

Chair: Mehdi K Jalayerian, PE, Life Member, Environmental Systems Design Inc. now Stantec Consulting Services, Chicago, IL

The recent technological advances in digital building control system can generate dynamic system operational data and space environment characteristics. This data can be used to actively manage buildings IAQ and temperature spikes and by leveraging the artificial intelligence process an automated and smart mitigation can be implemented to facilitate best space indoor air quality and comfort condition. This seminar discusses intelligent/smart building solutions and operational data management approaches for Class A Tall Office Buildings.

1. Automation and Remote Controls for Occupant Experience and Comfort

Thru A Shivakumar, Cohesion, Chicago, IL

2. Beyond Scheduling: Automation and AI in the New Era of Data Normalization

Isaac Townsend, Cohesion, Chicago, IL

3. Demystifying Building Certifications and Exploring Well in the Age of Health and Wellness

Chad Flores, Cohesion, Chicago, IL

9:45 AM - 10:45 AM

Seminar 40 (Intermediate)

Modern Pumping Design

Track: Hydronic Systems



Room: Great Lakes E

Sponsor: 6.1 Hydronic and Steam Equipment and Systems

Chair: Sarah Hilden, Associate, Trane, Onalaska, WI

Pump technology has changed significantly in the 21st century with the addition of modern motors. This seminar will discuss how pump efficiencies, speeds and associated controls have changed, unlocking opportunities for energy savings and carbon reduction.

1. Get the Most out of Your HVAC Pumps with Permanent Magnet Motors

David Lee, Associate, Armstrong Fluid Technology, Toronto, Canada

2. A Consulting Engineer's Guide to Specifying ECM/PM/Integrated Pumps

Dustin K Langille, BEMP and HBDP, Associate, Elara Engineering, HILLSIDE, IL

9:45 AM - 10:45 AM

Seminar 41 (Intermediate)

Natural Refrigerants in Refrigeration: Regulations and Applications

Track: Refrigeration and Refrigerants



Room: Great Lakes C

Sponsor: 8.1 Positive Displacement Compressors, TC 8.2 - Centrifugal Machines

Chair: Davide Ziviani, PhD, Full Member, Purdue University - Ray W. Herrick Laboratories, West Lafayette, IN

This seminar covers perspectives and challenges associated with natural refrigerants. The transition to low-GWP alternatives raises the question about the future role of natural refrigerants as long-term solution. Yet, flammability, cycle complexities, regulations and R&D requirements are aspects to be considered and evaluated. Presenters will provide insights on the state-of-the-art of different applications employing various natural refrigerants including CO₂, water and A3 refrigerants.

1. A3 Refrigerants in Refrigeration: Comparison of the Current Status in the USA and the EU

Riley B Barta, Associate, Purdue University, W LAFAYETTE, IN

2. High-Performance Refrigeration System for Medium Temperature Applications Using Transcritical CO2

Stefan Elbel, Full Member, Technische Universität Berlin, Germany, Berlin, Germany

3. The Pros and Cons of Water As a Refrigerant

Matthew Cambio, Principal Engineer, Full Member, Trane Technologies, LA CROSSE, WI

9:45 AM - 10:45 AM

Seminar 42 (Intermediate)

Occupant Health Must be Considered in Building Design, Operations and Maintenance

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Water Tower B

Sponsor: 7.9 Building Commissioning , Environmental Health Committee, SSPC62.1

Chair: Stephanie Taylor, MD, M Arch, Full Member, Building 4 Health, Inc., Austin, TX

The MTG-HWBE report approved by EHC explicitly states that the purpose of most buildings is for human occupancy and elaborates on the multiple effects of the built environment on occupant health. One charge to the MTG was to survey how ASHRAE can promote Health and Wellness in the Built Environment. This session will review the effect of buildings on health, spotlight relevant ASHRAE history and recognize the value of better indoor environments relative to their cost. These three presentations supports ASHRAE efforts to strengthen standards (for example 62.1, 62.2, 189.1) to better protect occupants when adopted as code.

1. Where Has ASHRAE Been on Health?

Andrew K Persily, Fellow Life Member, NIST, GAITHERSBURG, MD

2. The Building Does Matter for Occupant Health

Hoy R Bohanon Jr, PE, Life Member, Hoy Bohanon Engineering, PLLC, Denver, CO

3. Opportunities for ASHRAE to Lead

Stephanie Taylor, MD, M Arch, Full Member, Building 4 Health, Inc., Austin, TX

Tuesday, January 23, 10:30 AM - 11:45 AM

AHR Expo Session 3 (Intermediate)

Cutting-Edge Japanese Technologies on Advanced HVAC System and Equipment: SHASE Annual Award Winners

Track: HVAC&R Systems and Equipment

Room: South S401a

Chair: Akio Miyara, PhD, Full Member, Saga University, Saga Shi, Japan

The advanced air conditioning design method and air conditioning system that won the SHASE Technology Award will be presented. The first is an office building with a high-efficiency heat source system that uses a new heat load calculation to reduce the airflow of air conditioners and deliver chilled water at two different temperatures. The second is a multi-purpose arena, where a method of designing highly efficient air-conditioning systems for large spaces is applied. The third is a system that achieves both cleanliness and energy savings by using control logic that takes advantage of airflow characteristics in clean rooms.

1. Energy-Saving HVAC System and Design Methods for Office Buildings in Japan

Yuichi Nakagawa, Senior Project Engineer, NIHON SEKKEI, INC., Tokyo, Japan

2. HVAC Design System for Multi-Purpose Arenas and Pool Sport Complex Buildings

Hideaki Hoshino, Senior Project Engineer, NIHON SEKKEI, INC., Tokyo, Japan

3. Environmental Sensor-Based Control System for Fan Filter Units in Industrial Clean Rooms

Takayuki Someya, Chief, Shimizu Corporation, Tokyo, Japan

10:45 AM - 11:45 AM

AHR Expo Session 4 (Intermediate)

Understanding Regulatory Changes in Commercial Kitchen Ventilation

Track: HVAC&R Systems and Equipment

Room: South S402a

Sponsor: 5.10 Kitchen Ventilation

Chair: Derek W Schrock, Full Member, Halton Company, NASHVILLE, TN

Kitchens are deceptively complex and dynamic when it comes to controlling heat, humidity, and effluent, the standards referenced in building code are the minimum to prevent setting the restaurant on fire. In this seminar we'll look at why building code minimum will not get you to proper capture & containment of effluents, the importance it plays to human health and safety, as well as the impact to the dining experience. This seminar will also review changes to legislation, codes and standards across North America for engineers at the design stage and help identify challenges prior to a field correction notice.

1. Standards and Code Development and Application to Appliances in the Field

Mark Skierkiewicz, PE, Full Member, Underwriters Laboratories, LLC, Northbrook, IL

2. You Don't Get a Cookie for Not Burning Down the Building

Nissun Feiner, CHD, S-B-a Member, Delta-T Designs, Oro-Medonte, ON, Canada

Tuesday, January 23, 11:00 AM - 12:30 PM

Debate 2 (Intermediate)

Who's Afraid of the Net Zero Wolf?

Track: Decarbonization and Climate Change

Room: Great Lakes B

Chair: Mark A Lyles, New Buildings Institute, Portland, OR, Jim Edelson, Associate, New Buildings Institute, PORTLAND, OR, Kimberly Cheslak, Full Member, Pacific Northwest National Lab, RICHLAND, WA, Duane Jonlin, City of Seattle, Seattle, WA and Michael Waite, P.E., Full Member, American Council for an Energy-Efficient Economy

Almost everybody advocating for building decarbonization loves the concept of net zero, but aside from commercial buildings numbering only in hundreds, nobody is actually doing it. Even among progressive jurisdictions, only a minority have pledged to achieve zero carbon in some future year, and even those are not taking the most difficult steps today. Is now the time to pause momentarily and reconsider whether "net zero" is the right mountain for buildings to climb? This debate will explore multiple sides of 'net zero' and climate-aligned policies, and engage the audience to help shape, sway, or solidify current opinions and ideologies.

11:00 AM - 12:30 PM

Paper Session 22

Indoor Environmental Quality: From Airborne Infection Mitigation to Ceiling Fan Filtration

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Great Lakes F

Chair: Adrian M Wallace, Full Member, Johnson Controls, Inc., LIBERTY TWP, OH

This session examines research on indoor environmental quality (IEQ). The first presentation unfolds ASHRAE Standard 241's groundbreaking role in mitigating airborne infection risks, exploring the energy implications of various strategies to meet clean air requirements. The second delves into the fluid dynamics of ceiling fan filtration systems, enhancing indoor air quality by integration of gas removal media into fan blades. The third presentation tackles the challenge of managing Environmental Tobacco Smoke in facilities that permit smoking. Finally, the fourth presentation employs a data-driven approach to predict occupant thermal comfort and local thermal discomfort for multiple HVAC designs and weather scenarios.

1. ASHRAE Standard 241: Energy Implications of Different Strategies to Meet Equivalent Clean Air Requirements for Commercial and Educational Spaces (CH-24-C080)

Marwa Zaatari, PhD, Associate, D Zine Partners, Austin, TX

2. Ceiling Fan Filtration System: Fluid Dynamics Factors for Filters on Ceiling Fan Blades (CH-24-C081)

Daniel J Rush, Ph D Candidate, Student¹, Mengjia Tang, Associate² and Atila Novoselac, PhD, Associate³, (1)University of Texas at Austin, AUSTIN, TX, (2)Oak Ridge National Laboratory, OAK RIDGE, TN, (3)University Of Texas, AUSTIN, TX

3. Optimizing Indoor Air Quality for Facilities that Permit Smoking (CH-24-C082)

Mehran Salehi, Associate¹, John Williams² and Kathryn A Lee, P.E., Full Member², (1)Harris, VA, (2)Harris, Oakland, CA

4. Optimizing the Use of Room Air Purifiers in Combination with HVAC Filters for IAQ and Energy Efficiency (CH-24-C083)

Ramin Rezaei¹, Larry Rothenberg, J.D.² and Alan Viosca³, (1)Agentis Air LLC, Derwood, MD, (2)Agentis Air LLC, Rockville, MD, (3)Agentis Air LLC, rockville, MD

11:00 AM - 12:30 PM

Paper Session 23

Beyond Comfort: Exploring Dimensions of Indoor Environments

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Great Lakes G

Chair: Ratnesh Tiwari, Full Member, University of Maryland, COLLEGE PARK, MD

This session explores the facets of indoor environments through a compelling series of presentations. The first presentation delves into the intersection of energy burden, IEQ and mental health in the United Kingdom. The second dissects the impact of contextual variables on occupant comfort. The third introduces a novel Computational Fluid Dynamics (CFD) methodology for evaluating local thermal discomfort parameters, in compliance with ASHRAE Standard 55. The fourth presentation pioneers a data-driven approach to predict occupant thermal comfort and local thermal discomfort. The fifth presentation explores the influence of indoor greenery systems on occupant thermal comfort.

1. The Multi-Dimensionality of Energy Burden and Built Environment on Mental Health in the United Kingdom (CH-24-C084)

Wei-An Chen, Ph.D., Student and Chien-fei Chen, PhD, University of Tennessee, Knoxville, TN

2. Examining the Impact of Contextual Variables on Occupant Comfort: A Comparative Study of Thermal and Visual Comfort in Cold and Hot Climates (CH-24-C085)

Hamidreza Karimian¹, Rana Muhammad Raafat², Noha Osama², Mohamed Ouf, Associate¹ and Sherif Goubran², (1)Concordia University, Montreal, QC, Canada, (2)The American University in Cairo, Cairo, Egypt

3. Methodology to Evaluate the Local Thermal Discomfort Parameters Using CFD Simulations in Compliance with ASHRAE 55 Standard (CH-24-C086)

Aaditya Gajanan Ruiker, Associate Product Manager¹, Praveen Kumar Ramachandran, Product Manager, Full Member¹, Ruturaj Rajendra Patil, Product Analyst¹, Venu Kondala Rao Angirekula, Senior team lead¹ and Sandip Jadhav¹, (1)Center for Computational Technologies - CCTech, Pune, India

4. Predicting Occupant Thermal Comfort and Local Thermal Discomfort for Multiple HVAC Designs and Weather Scenarios with Data Driven Approach (CH-24-C087)

Sandip Jadhav¹, Prasad Rajendra Pawar¹, Sairandhri Rajendra Pawar, Team Lead¹, Rohit Chavan, Full Member¹ and Astik Patel¹, (1)Center for Computational Technologies - CCTech, Pune, India

5. Indoor Greenery Systems: How Do They Impact Occupant Thermal Comfort? (CH-24-C088)

Emmanuel Samuel Ndiketi Iddio, Student and Liping Wang, PhD, S-B-a Member, University of Wyoming, LARAMIE, WY

11:00 AM - 12:30 PM

Seminar 43 (Intermediate)

Climatic Impact on Internal Pressures and Indoor Environment of Mega Tall Buildings

Track: Tall Building Design



Room: Water Tower A

Sponsor: 9.12 Tall Buildings

Chair: Suzan Sun-Yuan, PE, Full Member, Environmental Systems Design, Inc., now Stantec Consulting Services, Chicago, IL
External wind conditions and local climate contribute to the building stack effect and change the character of the building HVAC System operation and indoor air quality. The envelope performance of the building also impacts the building's HVAC operation. Many tall buildings throughout the world are experiencing significant air movement both inside and outside the building. There are practical strategies that could be utilized to mitigate the impacts of building HVAC Systems. Current testing standards versus live measuring conditions show the difference. This session aims to improve the operation and conserve the energy.

1. Climatic Impact on Internal Pressures and Indoor Environment of Mega Tall Building

Mehdi K Jalayerian, PE, Life Member, Environmental Systems Design, Inc., now Stantec Consulting Services, Chicago, IL

2. Effect of Wind on Building Pressurization in Tall Buildings

Vincent Tang, Associate, RWDI, Toronto, ON, Canada

3. Future Climate and Pressure on Tall Buildings

Luke C H Leung, PE, BEMP, Fellow Member, Skidmore, Owings and Merrill LLP, Chicago, IL

11:00 AM - 12:30 PM

Seminar 44 (Intermediate)

Heat Pump Controlled Environment vs. Field Testing: Challenges and Perspectives

Track: HVAC&R Systems and Equipment



Room: Water Tower B

Sponsor: 8.11 Unitary and Room Air Conditioners and Heat Pumps, TC 8.4 - Air-to-Refrigerant Heat Transfer Equipment

Chair: Parveen Dhillon, Associate, National Renewable Energy Lab (NREL), W Lafayette, IN

This seminar explores the learnings and challenges associated with heat pump performance measurement in controlled laboratory environments and real-world field conditions. The presentations delve into the unique challenges and opportunities presented by each testing scenario. Attendees will gain insights into the benefits and limitations of controlled environment testing, where precise conditions can be maintained, as well as the advantages and complexities of field testing, which offers a more accurate representation of real-life scenarios. The seminar addresses key technical hurdles encountered in both settings and propose potential solutions to enhance the accuracy and reliability of heat pump performance assessments.

1. Air Mixers for Psychrometric Applications: Findings from ASHRAE RP-1733

Christian Konrad Ludwig Bach, Associate Member ASHRAE, Associate¹ and Hyunjin Park², (1)Oklahoma State University, OKLAHOMA CITY, OK, (2)Oklahoma state university, Stillwater, OK

2. Developing a Dynamic Load-Based Testing Methodology for Heat Pumps: Insights and Challenges

Parveen Dhillon, Associate¹ and James Braun, Ph.D., Fellow ASHRAE², (1)National Renewable Energy Lab (NREL), W Lafayette, IN, (2)Ray W. Herrick Laboratories, Purdue University, West Lafayette, IN

3. Laboratory Testing Variable Speed Heat Pumps in the Field? What We Learned from Testing Six Split System Heat Pumps

David P Yuill, PE, S-B-a Member, University of Nebraska, LINCOLN, NE

11:00 AM - 12:30 PM

Seminar 45 (Intermediate)

LIVESTREAM: Design Guidance for Climate Change

Track: Decarbonization and Climate Change



Room: Great Lakes A

Sponsor: 2.5 Global Climate Change, 4.2 Climatic Information , TC 2.8

Chair: Daniel L. Villa, PE, Full Member, Sandia National Laboratories, Alamo (virtual employee), TX

The increasing rate at which Earth's climate is changing is making it necessary to consider how designs in the built environment and HVAC&R are affected. Diligence to design for safety, comfort and efficiency for future, more severe conditions may be needed depending on local climate conditions. There is an increasing amount of information that enables modelers to do this by including future weather conditions. It is imperative to consider more rigorous approaches that embrace sustainability. This can include designing first for sufficiency, then for efficiency, and finally for offsetting carbon through renewables.

1. Climate and Weather Data: Availability and Challenges

Parag Rastogi, PhD, CEng, MCIBSE, MASHRAE, Full Member, GRESB, Glasgow, United Kingdom

2. Sufficiency-Efficiency-Renewable Framework to Adapt Buildings in a Changing Climate without Compounding the Problem

Eric L Peterson, PhD, PE, CEng, Full Member, Visiting Research Fellow-Univ. of LEEDS, Leeds, West Yorkshire, United Kingdom

3. Creating Building Resilience and Occupant Safety to Adapt to a Changing Climate

Janice K Means, PE, Fellow Life S-B-a Member, Retired from Lawrence Technological University, Southfield, MI

11:00 AM - 12:30 PM

Seminar 46 (Intermediate)

Optimization to Enable Predictive Controls and Scheduling for Grid-Interactive Efficient Buildings

Track: HVAC&R Controls



Room: Great Lakes E

Sponsor: 1.13 Optimization, 7.5 Smart Building Systems , 7.5, 1.4

Chair: Christopher R Laughman, Full Member, Mitsubishi Electric Research Lab, Waltham, MA

High performance grid-interactive buildings will require the successful integration of HVAC systems, energy storage, renewable energy generation and the electrical grid. Each of these subsystems interact on a wide range of timescales that present challenges for conventional control approaches. New predictive control and scheduling methods that rely on optimization to achieve high system-level performance while ensuring that important physical constraints are met represent a key pathway to engineering these complex systems in a systematic and robust manner. This seminar describes some candidate approaches and technologies for designing representative systems and provide practical examples demonstrating their efficacy.

1. Practical Grid-Responsive Predictive Control for Integrated Heat Pump Systems

Veronica A Adetola, Full Member, Pacific Northwest National Lab, RICHLAND, WA

2. Design and Optimization of Conventional Heat Pump with Thermal Energy Storage for Grid-Interactive Efficient Buildings

Mingzhe Liu, Ph.D., Student, Texas A&M University, COLLEGE STATION, TX

3. A Load Forecasting Tool for Participating in a Transactive Energy Market

Farhad Omar, Electrical Engineer, Associate, NIST, GAITHERSBURG, MD

11:00 AM - 12:30 PM

Seminar 47 (Intermediate)

The Future Is Electrifying: Zero-Carbon Case Studies Under Moderate Climate

Track: Decarbonization and Climate Change



Room: Great Lakes C

Sponsor: 6.7 Solar and Other Renewable Energies, 7.6 Building Energy Performance , TC9.7; TC7.5; TC 3.2

Chair: Constantinos A Balaras, PhD, Fellow Member, Institute for Environmental Research & Sustainable Development, national Observatory of Athens, VRILISSIA, Greece

The building sector is expected to play a key role in the climate change mitigation and resilience of the built environment, through the deployment of net-zero, all-electric buildings. Achieving net-zero (energy and carbon) performance targets require us to transform how we design, build and operate buildings. This seminar provides insights on the challenges and solutions available regarding the design, construction, and operation of net-zero buildings. Four case studies under cold temperate climate will be showcased: an office, an institutional, a K-12 building, and a municipal library.

1. Case Study 1: Office Building

Konstantinos Kapsis, Associate, University of Waterloo, WATERLOO, ON, Canada

2. Case Study 2: Institutional Building

Anthony Cupido, P.Eng., Mohawk College, Hamilton, ON, Canada

3. Case Study 3: K-12 Building

Tianyuan LI, Associate, University of Waterloo, WATERLOO, ON, Canada

4. Case Study 4: Municipal Library

Andreas K Athienitis, Ph.D., P.E., Fellow Life Member, Concordia University, Montreal, QC, Canada

Tuesday, January 23, 12:00 PM - 1:00 PM

AHR Expo Session 5 (Intermediate)

Field Studies of Smart Thermostats for Energy-Efficient and Grid Flexibility Operations in Residential and Light Commercial

Track: Decarbonization and Climate Change

Room: South S401a

Sponsor: 7.5 Smart Building Systems, 1.4 Control Theory and Application

Chair: Li Song, PhD, S-B-a Member, University of Oklahoma, Norman, OK

Significant energy reduction and grid flexibility opportunities exist in buildings through advanced controls. However, the implementation of such controls is limited in residential and light commercial buildings due to the lack of building energy management systems. Widespread use of the Internet of Things (IoT), including smart thermostats, provides an opportunity for the implementation of advanced control without prohibitive control retrofit expenses. This seminar presents two field studies that use smart thermostats to obtain energy efficient and grid-flexibility operations in residential and light commercial buildings. In addition, savings and impact analysis are presented using field testing results.

1. Building a Greener Future: Smart Thermostat-Based Grid-Responsive Control and Savings at Multiple Buildings

Donghun Kim, Full Member, Lawrence Berkeley National Laboratory, Berkeley, CA

2. Development, Implementation and Impact Analysis of Model Predictive Control-Based Optimal Precooling Using Smart Homes Thermostats

Yilin Jiang, Student, Pacific Northwest National Laboratory, Norman, OK

Tuesday, January 23, 1:00 PM - 1:30 PM

Seminar (Basic)

TC Special Session: The Winning Numbers: 13, 36, 135, 195, 223P, 231P. Understanding TC 1.4's Standards and Guidelines for YEA!

Track: Fundamentals and Applications

Room:

Chair: Michelle Kiana Shadpour, Associate, SC Engineers, Inc, San Diego, CA

TC 1.4 is the cognizant technical committee for Guideline 13, Guideline 36, Standard 135, Standard 195, Standard 223P, and Standard 231P. Understanding these Standards and Guidelines and how to use them can make engineers feel like they've hit the engineering jackpot! Learn what's included in these Guidelines and Standards, their relevance, and how they can be used by controls and non-controls engineers.

Understanding TC 1.4's Standards and Guidelines for Yea

Elise Marie Backstrom, P.E., Full Member, Exyte U.S., Gilbert, AZ

Tuesday, January 23, 1:30 PM - 2:00 PM

Sponsor Tech Talks (Basic)

Lessons Learned in Direct Evaporative Media System Design

Track: HVAC&R Systems and Equipment

Room: Water Tower A

Direct evaporative cooling (DEC) systems are a great way to economically provide cooling while efficiently using water and power resources, however, designing and applying them is not as simple as you may think. This presentation will cover some of the more common errors in DEC design that can lead to performance issues, as well as best practices to avoid them. We'll also touch on a few ways to optimize DEC systems for water use and media life.

Presenter: William Truong

Title: Business Development Manager, Data Centers

Company: Condaair

Lessons Learned in Direct Evaporative Media System Design

William Truong, Associate, Condaair, GA

1:30 PM - 3:00 PM

AHR Expo Session 7 (Intermediate)

Decarbonizing Building Space Heating In Cold Climates: Examining Air-Source VRF Heat Pump systems

Track: Decarbonization and Climate Change

Room: South S401a

Sponsor: 8.7 Variable Refrigerant Flow (VRF)

Chair: Badri Patel, Full Member, Johnson Controls, Toronto, ON, Canada

Space heating in cold climates accounts for approximately 40% of commercial building energy use in North America, and most of that comes from directly burning fossil fuels. Variable Refrigerant Flow (VRF) systems are an important heat pump technology to electrify commercial buildings and take advantage of renewable energy. Recent VRF advancements allow these systems to operate up to -22°F ambient wet-bulb, while upcoming refrigerant transition will be a good opportunity to switch to VRF. This seminar will inform the audience of VRF systems' effectiveness in cold climates, including applications, experiences, and lessons learned.

1. Air-Source VRF in the Midwest: Does It Work?

Chris Sala, Slipstream, IL

3. University Study: Upgrading with VRF in an Illinois Dorm

Mohammad Heidarinejad, Ph.D., P.E., S-B-a Member, Illinois Institute of Technology, CHICAGO, IL

4. Field Validation of VRF System Performance in Cold Climates

David Korn, Ridgeline Energy Analytics, Stow, MA

1:30 PM - 3:00 PM

Paper Session 24

Optimizing Indoor Air Quality and Ventilation Strategies (Poster)

Track: Ventilation, Indoor Air Quality and Air Distribution Systems



Room: Great Lakes F

Chair: Mina Agarabi, Full Member, Agarabi Engineering, PLLC, Brooklyn, NY

This session explores IAQ and ventilation strategies. The first presentation examines the unintended formation of air contaminants by ultraviolet germicidal irradiation systems. The second introduces a novel approach to predict and forecast carbon dioxide concentrations in indoor environments. The third delves into the effects of diffuser location on ventilated airflow and contamination dispersion. The fourth models the effectiveness of portable air cleaners in conjunction with open windows. The fifth presents findings from a national survey on IAQ awareness in the US. The final presentation investigates the effects of airflow adjustments and room layout on aerosol propagation in a university classroom.

1. Formation of Air Contaminants By Ultraviolet Germicidal Irradiation System: Effects of Ventilation Strategy and Ventilation Rate (CH-24-C089)

Seongjun Park, Ph.D., Student¹, Youngbo Won, Dr., Student² and Donghyun Rim, Associate professor, Member³, (1)Pennsylvania State University, UNIVERSITY PARK, PA, (2)Pennsylvania State University, (3)Pennsylvania State University, University Park, PA

2. Investigating Ventilation Effectiveness and CO2 Concentration in Indoor Environments: A CFD Simulation and Random Forest-Based Predictive Modeling Approach (CH-24-C090)

Enea Dimitris Tseno, Associate Member, Loughborough University, Loughborough, United Kingdom

3. The Effects of Diffuser Location on Ventilated Airflow and Contamination Dispersion: A Numerical Simulation Study (CH-24-C091)

Saeid Chahardoli, Student¹, Mina Lesan, Student Member¹ and Arup Bhattacharya, Ph.D., Associate², (1)Louisiana State University, Baton Rouge, LA, (2)Louisiana State University, BATON ROUGE, LA

4. Modeling the Effectiveness of Portable Air Cleaners with Open Windows (CH-24-C092)

Vito Ilacqua, PhD, Associate, US EPA, Washington, DC

5. Awareness and Information Needs about Indoor Air Quality in the US: A National Survey (CH-24-C093)

Vito Ilacqua, PhD, Associate¹, Cynthia Jorgensen, DrPH² and Allison Michelle Fisher, MPH², (1)US EPA, Washington, DC, (2)US Centers for Diseases Control and Prevention, Atlanta, GA

6. Investigating the Effects of Airflow Adjustments and Room Layout on Aerosol Propagation in a University Classroom using CFD (CH-24-001)

Taylor N Suess, MS, PE, Associate¹, Scott Deprez² and Stephen Gent², (1)Nederveld, Larchwood, IA, (2), West Palm Beach, FL

1:30 PM - 3:00 PM

Paper Session 25

Innovations in Sustainable Heating and Cooling Systems (Poster)

Track: HVAC&R Systems and Equipment



Room: Great Lakes G

Chair: David A Yashar, PhD, Full Member, NIST, GAITHERSBURG, MD

Explore cutting-edge advancements in sustainable heating and cooling systems. The first presentation delves into a comparative performance analysis of various substation configurations in 5th Generation District Heating and Cooling Systems. The second presentation explores integrating dry cooler fluid to a vertical ground source heat pump to increase cost-effectiveness and maintain energy efficiency. The third presentation presents a novel approach to dehumidification through a model of a desiccant-coated Kirigami-based heat exchanger. The fourth presentation details the conversion of an air-source HPWH to a water-source HPWH with comparable performance. The fifth presentation estimates power generation from roof-mounted wind turbines in urban settings.

1. A Comparative Analysis of Energy Performance of Different Substation Configurations in the 5th Generation District Energy Systems (CH-24-C094)

Yuhang Zhang, Student¹, Mingzhe Liu, Ph.D., Student¹ and Zheng O'Neill, Ph.D., P.E., Fellow Member², (1)Texas A&M University, COLLEGE STATION, TX, (2)Texas A&M University, College Station, TX

2. Development of a High-Efficiency and Cost-Effective Ground Source Heat Pump System for Subtropical Climate Applications (CH-24-C095)

Xiaoou Hu, Student, Yao Yu, Ph.D., BEMP and BEAP, Associate and Xuelei Xiao, Student, North Dakota State University, FARGO, ND

3. Modeling and Simulation of a Desiccant Coated Kirigami-Based Heat Exchanger (CH-24-C096)

Nathaniel Smith, Student¹, Zhiyao Yang, Ph.D., Associate², Mingzhe Liu, Ph.D., Student², Zheng O'Neill, Ph.D., P.E., Fellow Member³ and Shu Yang, PhD⁴, (1)Texas A&M University, College Station, TX, (2)Texas A&M University, COLLEGE STATION, TX, (3)Texas A&M University, College Station, TX, (4)University of Pennsylvania, Philadelphia, PA

4. Conversion of a Transcritical CO₂ Heat Pump Water Heater from an Air-Source to a Water-Source Configuration (CH-24-C097)

Kayla Jean Lewry, Student and Jeremy Sager, CanmetENERGY, Ottawa, ON, Canada

5. Estimating the Power Produced by a Roof-Mounted Wind Turbine in an Urban Setting (CH-24-002)

James A Mathias, PE, Full Member¹, Kyle Reed Ozier² and Hossein Eslamiat², (1)Southern Illinois University, CARBONDALE, IL, (2)Southern Illinois University, Carbondale, IL

1:30 PM - 3:00 PM

Seminar 49 (Intermediate)

LIVESTREAM: Emerging Technologies in Tall Buildings

Track: Tall Building Design



Room: Great Lakes A

Sponsor: 9.12 Tall Buildings, 7.5 Smart Building Systems

Chair: David William Norris, Mechanical Engineer, Associate, Aqua Air Engineering, Bellevue, WA

As more people flock to cities, the world is building vertically. This seminar aims to share the environmental and technological advancements in engineering design in high-rise buildings. Come tour buildings in Chicago and Japan. Explore technologies in decarbonization, carbon capture, machine learning, hybrid wind ventilation and artificial intelligence. Get a glimpse of the present and future of smart and tall buildings.

1. Urban Sequoia: Net Zero Whole Life Carbon

Luke C H Leung, PE, BEMP, Fellow Member, Skidmore Owings & Merrill, CHICAGO, IL

2. Design Methods for Environmental Purposes in High-Rise Complex Buildings

Ken Kaneko, Group Leader, TAKENAKA CORPORATION, Aichi, Japan

3. Connecting Tokyo with the Environment

Hirofuka Kubo, Eng, Associate, NIKKEN SEKKEI LTD, Higashi Ku, Japan

4. Smart Office Building in Chicago

Mehdi K Jalayerian, PE, Life Member, Environmental Systems Design Inc. now Stantec Consulting Services, Chicago, IL

Tuesday, January 23, 1:45 PM - 2:45 PM
AHR Expo Session 8 (Intermediate)

CO2 a Well Revival Natural Refrigerant

Track: Refrigeration and Refrigerants

Room: South S402a

Sponsor: 10.2 Refrigeration Applications

Chair: Kathleen A Neault, P eng, Full Member, Refri-Ozone Inc, Granby, QC, Canada

The phase-out of refrigerants that affect Ozone Depletion Potential (ODP) and Global Warming Potential (GWP) has led to the revival of natural refrigerants such as CO2 and Ammonia. The use of CO2 is becoming more predominant. The CO2 is getting widely spread. This seminar presents to different applications of CO2 system. A case study of an ice rink and a cascade system using CO2 and ammonia.

1. Case Study for Replacing the Ice Rink Refrigeration System from a High to a Low GWP Refrigerant

Benoit Rodier, P eng, Full Member, CIMCO Refrigeration, Burlington, ON, Canada

2. Cascade CO2 and Ammonia Case Study

Apichit Lumlerpongpana, Fellow Life Member, ITC group, Bangkok, Thailand

Tuesday, January 23, 3:15 PM - 4:45 PM
Paper Session 26

Thermal Comfort and Indoor Air Quality for Occupant Well-Being (Poster)

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Great Lakes F

Chair: Sammy Houssainy, National Renewable Energy Laboratory, MISSION VIEJO, CA

This session explores optimization of building environments for thermal comfort and indoor air quality (IAQ). The first presentation details the performance evaluation of interior shading systems in hot climates in mitigating solar heat gain and glare. The second introduces a data-driven approach to predicting thermal comfort levels using non-intrusive methods. The third presentation addresses the housing challenges in rural Alaskan communities, exploring efficiency, climate resilience, and IAQ. The fourth investigates the effects of air curtain operation on airborne particulate infiltration. Finally, the fifth presentation presents an advanced thermal manikin for assessing local thermal comfort.

1. Performance Evaluation of Interior Glare and Solar Heat Gain Shading Systems in Extremely Hot Climates Zone (CH-24-C099)

Ayman Youssef, PE, Full Member, Ahmed Ali Alzahrani, Eng, Associate and Abdulmajeed Almohanna, Eng, Associate, Saudi Aramco, Dhahran, Saudi Arabia

2. Predicting Thermal Comfort Levels Using Facial Thermal Imaging and Skin Temperature: A Data-Driven Approach (CH-24-C100)

Joshua Vasudevan, Eng, Associate¹ and Mahroo Eftekhari, CEng, Full Member², (1)Chord Consult, Loughborough, United Kingdom, (2)Loughborough University, Loughborough, United Kingdom

3. Measuring the Effects of Air Curtain Operation on Infiltration of Airborne Particulates through an Opening (CH-24-C102)

Andy A Ross, Mechanical Engineer and Naga Thiyagarajan, Mars Air Systems, Gardena, CA

4. Advanced Thermal Manikin for Assessing Local Thermal Comfort: Development of a New Generation of Hardware Architecture (CH-24-C103)

Matei Razvan Georgescu¹, Paul Danca¹, Alexandru Cernei¹, Frédéric Thevenet², Marie Verrielle² and Ilinca Nastase, Eng, Full Member¹, (1)CAMBI Research Center, Technical University of Civil Engineering Bucharest, Bucharest, Romania, (2)IMT Nord Europe, Institut Mines Télécom, Centre for Energy and Environment, Lille, France

3:15 PM - 4:45 PM

Seminar 50 (Advanced)

LIVESTREAM: Electrification of Tall Buildings for Decarbonization and Future Proofing

Track: Tall Building Design



Room: Great Lakes A

Sponsor: 9.12 Tall Buildings, 6.9 Thermal Storage

Chair: Rick M Heiden, Full Member, Trane, La Crosse, WI

To meet decarbonization goals, several cities in the U.S. and abroad have prohibited using fossil fuels to heat buildings. Tall buildings within these cities present unique challenges to decarbonize, especially heating in cold-climates. The objectives of this seminar are to provide tall-building design strategies for electrified heating systems, future-proofing electrical infrastructure and evaluating life-cycle carbon. The speakers will draw from pioneering cold-climate projects on the east coast and mid-west along with Chicago's rich history of all electric buildings in order to provide future-proofing tactics for the tall buildings of tomorrow.

1. Heating with Ice: An Electrification Solution

Tyler Joseph Schott, P.E., Jaros, Baum & Bolles Consulting Engineers LLP, New York, NY

2. An Innovative Medium-Voltage Upgrade that Powers Skyscrapers Higher

Mehdi K Jalayerian, PE, Life Member, Environmental Systems Design Inc. now Stantec Consulting Services, Chicago, IL

3. Whole Life Carbon in Tall Buildings

Luke C H Leung, PE, BEMP, Fellow Member, Skidmore Owings & Merrill, CHICAGO, IL

Wednesday, January 24

Wednesday, January 24, 8:00 AM - 9:30 AM

Panel 10 (Intermediate)

Decarbonization of the Federal Building Portfolio

Track: Decarbonization and Climate Change

Room: Great Lakes B

Sponsor: 2.8 Building Environmental Impacts and Sustainability

Chair: Kinga Porst Hydras, Full Member, General Service Administration, Washington DC, DC

Decarbonizing our vast commercial and public building stock will require replacing fossil fuel powered equipment and appliances with electric technologies nationwide. But where to begin and how to conduct this process smartly, strategically and cost-effectively? This session will provide a variety of perspectives to help building decision makers and implementers effect this needed transformation.

This Panel will cover technical questions, like appropriate technologies to replace gas-powered HVAC systems; financial issues, like how to incorporate electrification in performance contracts or other financing vehicles; and practical challenges like how to adjust policies such as life cycle costing guidance to make beneficial electrification happen.

1. Decarbonization of the Federal Building Portfolio

Kinga Porst Hydras, Full Member, General Service Administration, Washington DC, DC

2. Renovation or New Construction: Assessing the Embodied Carbon of Buildings

Sandrine Schultz, GSA, NEW YORK, NY

3. U.S. Federal Government Approach to Decarbonization: Sftool and Product Search

Michael Bloom, U.S. General Services Administration, General Service Administration, Washington DC, DC

8:00 AM - 9:30 AM

Paper Session 27

Considerations in Building Performance Analysis

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Great Lakes F

Chair: Paul A Torcellini, P.E., Fellow Member, NREL, LAKEWOOD, CO, United States

This session explores research and methodologies shaping building performance analysis. The first presentation employs Bayesian Causal Inference to enhance occupant-centric building system operation. The second tackles the challenge of missing data in monitored buildings. The third investigates representing occupant behavior diversity in building performance simulations, comparing sorting and clustering methods for selecting occupant behavior profiles. The fourth introduces a numerical model analyzing energy fluxes in fenestration integrating luminescent solar concentrators. Lastly, the fifth explores utilizing contrast-to-noise ratio for identifying thermal anomalies in northern buildings, offering a low-cost IR camera solution for remote regions.

1. Bayesian Causal Inference for Occupant-Centric Building System Operation (CH-24-C104)

Jinyoung Ko, Student and Seungjae Lee, Ph.D., Associate, University of Toronto, Toronto, ON, Canada

2. Missing Data in Monitored Buildings? Comparison of Data Imputation Approaches for Different Situations (CH-24-C105)

Jean Rouleau, P.Eng., Ph.D., Student and Louis Gosselin, P.Eng., Ph.D., S-B-a Member, Université Laval, Quebec City, QC, Canada

3. How to Represent Occupant Behavior Diversity in Building Performance Simulations? Comparison of Occupant Behavior Profiles Selection Methods and Their Applications (CH-24-C106)

Debby Veillette, Ph.D. Candidate, Student, Jean Rouleau, P.Eng., Ph.D., Student and Louis Gosselin, P.Eng., Ph.D., S-B-a Member, Université Laval, Quebec City, Canada

4. Modeling of Energy Fluxes in Fenestration Integrating Luminescent Solar Concentrators (CH-24-C107)

Charles-Eric Gagnon, Student, Student and Louis Gosselin, P.Eng., Ph.D., S-B-a Member, Université Laval, Quebec City, QC, Canada

5. Utilization of Contrast-to-Noise Ratio for Identifying Thermal Anomalies in Northern Buildings with a Low-Cost IR Camera (CH-24-C108)

Pamela Corriveau Peev, Student, Student and Louis Gosselin, P.Eng., Ph.D., S-B-a Member, Université Laval, Quebec City, QC, Canada

8:00 AM - 9:30 AM

Paper Session 28

Optimizing Occupant Comfort for Energy Efficiency

Track: Fundamentals and Applications



Room: Great Lakes G

Chair: John Dunlap, Fellow ASHRAE, Salas O'Brien, Richmond, VA

This session explores considerations in improving energy savings while maintaining occupant comfort. The first presentation assesses energy savings using Phase Change Materials (PCM) in ceiling tiles for enhanced acoustics and reduced consumption; the second introduces a 3D-printed Microchannel Polymer Heat Exchanger, offering a lightweight alternative for residential cooling; the third addresses the need to bridge gaps in MEP education, proposing curriculum enhancements; the fourth optimizes window properties for energy efficiency and visual comfort under uncertain shading configurations; and the final presentation evaluates thermal satisfaction scales, correlating sensation and preference votes.

1. Experimental Assessment of Energy Savings with Ceiling Tiles Made with Phase Change Materials in Combination with Acoustical Ceilings in a Return Air Plenum (CH-24-C109)

Jason Cavanaugh, Affiliate¹, William Frantz, Member² and Gourish Sirdeshpande, Full Member¹, (1)Armstrong World Industries, Lancaster, PA, (2)Armstrong World Industries Inc., Elizabethtown, PA

2. Design and Testing of a Novel Microchannel Polymer Heat Exchanger for Applications in Residential Cooling (CH-24-C110)

Emily Fricke, Student, Valentina Arévalo Arredondo, Erfan Rasouli, Ph.D. and Vinod Narayanan, Ph.D., S-B-a Member, University of California Davis, Davis, CA

3. Bridging the Gap: A Case Study on Enhancing Understanding of MEP Fundamentals and Applications to Meet Industry Needs (CH-24-C111)

Joseph Ryan Manuel, MBA, LEED® Green Associate™, Full Member, Anthony E. Sparkling, Ph.D. and John D. Callahan, Purdue University - Construction Management, West Lafayette, IN

4. Evaluation of Thermal Satisfaction Scales through the Analysis of Sensation and Preference Votes (CH-24-C113)

Federica Morandi¹, Andrea Gasparella¹, Athanasios Tzempelikos, PhD, Full Member², Ilaria Pittana³ and Francesca Cappelletti, Associate³, (1)Free University of Bolzano, Bolzano, Italy, (2)Purdue University - Civil Engineering, West Lafayette, IN, (3)University IUAV of Venice, Venice, Italy

8:00 AM - 9:30 AM

Seminar 51 (Intermediate)

Emerging Building Envelope Materials: High-Performance, Low-Embodied Carbon Materials for Decarbonization

Track: Decarbonization and Climate Change



Room: Water Tower A

Sponsor: 4.4 Building Materials and Building Envelope Performance

Chair: Emishaw D Iffa, Full Member, Oak Ridge National Laboratory, Oak Ridge, TN

With the goal of achieving net-zero greenhouse gas emissions economy-wide by 2050, the building sector's interest towards high-performance and low-embodied carbon materials development and deployment has spiked. The seminar aims to explore the most recent research and advancements in sustainable building materials development, with a specific focus on their thermal performance, durability, carbon footprint and overall environmental sustainability.

1. Low-Cost Fibers for Vacuum Insulation Panels Core Materials

Rui Zhang, Associate, Oak Ridge National Laboratory, OAK RIDGE, TN

2. Developing a Database of Bio-Based Materials for Building Envelope Applications

Mengjia Tang, Associate, Oak Ridge National Laboratory, OAK RIDGE, TN

3. Development of an Experimental Procedure to Assess Thermal Properties of an Insulation Material Composed of Pleurotus Ostreatus Mycelium and Ash Wood Chips

Wahid Maref, P. Eng of Ontario, Full Member, Valérie Grenon and Claudiane Ouellet-Plamondon, Ecole de Technologie Supérieure (ETS), Orléans, Canada

4. Whole Building Life Cycle Assessment (wbLCA) Study on Residential Archetype New Buildings

Mehdi Ghobadi, Associate, NRC, Saskatoon, SK, Canada

8:00 AM - 9:30 AM

Seminar 52 (Basic)

From Laboratory to Ratings to Field: How Can Sound Data Differ Across Testing, Manufacturing and Installing HVAC Equipment?

Track: HVAC&R Systems and Equipment



Room: Great Lakes C

Sponsor: 2.6 Sound and Vibration

Chair: Paul Francis Bauch, Full Member, Johnson Controls, York, PA

Sound testing of HVAC equipment can be a complicated process requiring specialized instrumentation and test chambers. Manufacturers often expend significant resources to measure sound power levels of their products for developing sound ratings. Certain assumptions are made during this process and the selection, manufacturing and installation of equipment can lead to issues where the actual sound in the field does not align with the original rating. This seminar provides an overview of equipment sound standards, expand on assumptions made within those standards, and describe what can and cannot be done in the field to validate equipment sound performance.

1. Sound Testing of HVAC Equipment

E Curtis Eichelberger Jr, Eichelberger Acoustics LLC, Fellow Member, Eichelberger Acoustics LLC, Lancaster, PA

2. Creating HVAC Equipment Sound Ratings from Test Data

Derrick Paul Knight, Lead Acoustic Engineer, Full Member, Trane Technologies, La Crosse, WI

3. Using Cutting Edge Acoustic Evaluation Tools to Bridge the Gap between Field Testing and Lab Performance

Erik T Miller-Klein, PE, Full Member, Tenor Engineering Group LLC, Seattle, WA

8:00 AM - 9:30 AM

Seminar 53 (Intermediate)

LIVESTREAM: Driving Existing Building Decarbonization through Energy Efficiency and Greenhouse Gas Emissions Reduction with ASHRAE Standard 100

Track: Decarbonization and Climate Change



Room: Great Lakes A

Sponsor: 7.6 Building Energy Performance, SSPC 100

Chair: Jamie Kono, PE, Associate, Pacific Northwest National Laboratory, Atlanta, GA

How do existing buildings achieve decarbonization goals? ASHRAE Standard 100 provides a framework for improving existing building energy and emission performance through energy management and O&M best practices, achieving energy and emissions performance targets, and conducting energy audits to achieve energy and emissions goals. Learn about Standard 100's recent updates to include GHG emissions performance, how Standard 100 is being used by jurisdictions to achieve climate goals, and how you can prepare your buildings for Standard 100 compliance.

1. Standard 100 Overview: Energy Efficiency in Existing Buildings

Kimberly Cheslak, Full Member, Pacific Northwest National Laboratory, Richland, WA

2. Standard 100 Updates: GHG Performance and Target Development

Jamie Kono, PE, Associate, Pacific Northwest National Laboratory, Atlanta, GA

3. Achieving Decarbonization Goals Using Standard 100: Washington State

Emily Salzberg, Washington State Department of Commerce, Olympia, WA

4. Achieving Decarbonization Goals Using Standard 100: Oregon

Blake J. Shelide, PE, Full Member, Oregon Department of Energy, Salem, OR

5. The Consulting Engineer's Perspective: Guiding a Washington Office Building through Standard 100 Compliance

Jamie Kono, PE, Associate, Pacific Northwest National Laboratory, Atlanta, GA

8:00 AM - 9:30 AM

Seminar 54 (Intermediate)

The Final Frontier: Developing Cost-Effective Retrofit Strategies for Residential Wall Assemblies

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Water Tower B

Sponsor: 1.12 Moisture Management in Buildings, TC4.4

Chair: Andre O Desjarlais, Program Manager, Oak Ridge National Lab, Oak Ridge, TN

Enclosure retrofits targeting envelope losses can save significant energy, reduce greenhouse gas emissions, and improve thermal comfort. The Oak Ridge National Laboratory, Pacific Northwest National Laboratory, and the University of Minnesota have been conducting a three-year study of residential retrofit wall systems. This study includes comprehensive literature review, the involvement of an expert advisory group made up of thermal enclosure experts, small-scale experimental in-situ testing of the wall assemblies, and energy and hygrothermal simulation of wall assemblies to produce a techno-economic study of residential wall systems for deep energy retrofits. This seminar summarizes the findings of this research project.

1. Options for Exterior Wall Upgrades Supporting Deep-Energy Retrofits in Residential Buildings

Patricia Gunderson, Associate Member, Pacific Northwest National Laboratory, Richland, WA

2. In Situ Testing for PNNL/ORNL/UMN Wall Insulation Upgrade Study

Garrett E Mosiman, Center for Sustainable Building Research, University of Minnesota, Minneapolis, MN

3. Do Wall Retrofits Compromise the Service Life of Residential Buildings?

Andre O Desjarlais, Program Manager, Oak Ridge National Lab, Oak Ridge, TN

8:00 AM - 9:30 AM

Seminar 55 (Intermediate)

True Building Controls Interoperability: New Digital Solutions Enabled by Proposed ASHRAE Standards 223P and 231P

Track: HVAC&R Controls



Room: Great Lakes E

Sponsor: 1.4 Control Theory and Application, 7.5 Smart Building Systems

Chair: Paul W Ehrlich, Full Member, Building Intelligence Group LLC, Afton, MN

Enhancing control sequences in commercial buildings stands out as a compelling approach for improved efficiency and decarbonization. Modern controls are software applications that hold the potential for widespread deployment with minimal capital investment. Yet, the actual implementation process is presently fragmented and inefficient, primarily relying on manual transfers of vague English-language documents that are interpreted by engineers and translated into building-specific and vendor-specific code. This seminar discusses recent progress in digitization and interoperability through the introduction of two new ASHRAE standards. These standards enable new workflows promising to scale up efficiency and decarbonization strategies across the United States.

1. Digitizing the Delivery of Controls and Analytics through Proposed ASHRAE Standards 223P and 231P

Gabe Fierro, Dr., Associate, Colorado School of Mines, Golden, CO

2. Standardizing the Controls Delivery through ASHRAE 231P

Anand Krishnan Prakash, Lawrence Berkeley National Laboratory, Berkeley, CA

3. Advancing Building Control Digitization: Seamlessly Integrating ASHRAE 223P and CDL Framework for Enhanced Efficiency and Data Exchange

Parastoo Delgoshaei, Associate, NIST, GAITHERSBURG, MD

Wednesday, January 24, 9:45 AM - 10:45 AM

Panel 11 (Basic)

LIVESTREAM: Lifting Up Underserved and Rural Schools with ASHRAE and DOE LBNL

Track: Comfort, Indoor Environmental Quality and Energy Efficiency

Room: Great Lakes A

Sponsor: 9.7 Educational Facilities, Government Affairs Committee, ASHRAE DOE Schools Pilot Program

Chair: John Constantine, PE, Full Member, Mechanical Engineer, Merritt Island, FL

ASHRAE, the U.S. Department of Energy (DOE), and Lawrence Berkeley National Laboratory (LBNL) are partners to support ASHRAE Chapter outreach to local education agencies (LEAs) on improving IAQ and energy efficiency in underserved and rural school facilities. Armed with design expertise, including the ASHRAE Design Guidance for Education Facilities and other resources developed from the partnership, panelists will offer knowledge and insights on planning for these improvements with LEAs, guidance on seeking out and applying for available funding, perspectives from DOE, LBNL, and participating Chapters on successes and lessons learned, and future funding opportunities for LEAs.

1. ASHRAE Memphis Chapter Successes and Lessons Learned

Lionel A Davis II, Associate, Johnson Controls, Inc., Memphis, TN

2. TC 9.7 Perspectives with School Improvements

Rajnish B Setty, Full Member, Setty, Washington, DC

3. Government Outreach Experiences with Ashrae Detroit Chapter

Sonya M Pouncy, CEM, LEED AP, Full Member, Building Vitals, Detroit, MI

4. Current and Upcoming Federal Funding for Schools

Cindy Regnier, P.E., Full Member, Lawrence Berkley National Laboratory, Berkley, CA

9:45 AM - 10:45 AM

Paper Session 29

Water Heating Systems

Track: Hydronic Systems



Room: Great Lakes F

Chair: Daniel L. Villa, PE, Full Member, Sandia National Laboratories, ALBUQUERQUE, NM

This session explores advancements in hot water systems. The first presentation introduces an innovative solar water heating system integrated with encapsulated Phase Change Material (PCM) storage, which ensures consistent hot water supply during low solar radiation, achieving substantial energy savings. The second focuses on Heat Pump Water Heating (HPWH) for

multifamily buildings in cold climates, addressing cost issues and proposing configurations to lower energy burdens for residences with low to moderate incomes. The third delves into detailed measurements of heating hot water distribution heat losses, providing insights into unintentional heat losses and distribution efficiency in office and lab buildings.

1. Heat Pump Water Heating for Multifamily Buildings in Cold Climates to Reduce the Energy Burden for Residences with Low to Moderate Incomes (CH-24-C115)

Joseph D Rendall, Associate¹, Kashif Nawaz, PhD, Associate¹, Jian Sun, Full Member¹, Ahmed Elatar, Associate¹, Mini Malhotra, Ph.D.¹, Yanfei Li, Ph.D., Associate¹, William Worek, Fellow ASHRAE², Gary Klein, Owner³ and Finnian Casey, Student⁴, (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)Argonne National Laboratory, Lemont, IL, (3)Gary Klein and Associates, (4)University of Tennessee, Knoxville, TN

2. Heating Hot Water Distribution Heat Losses: Detailed Measurement (CH-24-C116)

David R Vernon, PhD, Full Member¹, Robert McMurry¹ and Paul Raftery, PhD, Full Member², (1)Western Cooling Efficiency Center, UC Davis, Davis, CA, (2)Center for the Built Environment, UC Berkeley, Berkeley, CA

9:45 AM - 10:45 AM

Paper Session 30

Water Quality HVAC Hydronic Systems, Thermally Anisotropic Building Envelopes and Radiant Heating/Cooling Efficiency

Track: Hydronic Systems



Room: Great Lakes G

Chair: Mahroo Eftekhari, CEng, Full Member, Loughborough University, Loughborough, United Kingdom

The first presentation delves into an international review of water quality and corrosion in HVAC hydronic systems, addressing the impact on energy performance, heat transfer, and system longevity. The second introduces Thermally Anisotropic Building Envelopes (TABE) integrated into panelized metal construction, showcasing laboratory evaluations, numerical studies, and potential energy-saving applications. The third explores the energy efficiency of water-based radiant heating/cooling systems, focusing on experimental measurements and comparisons of three dry radiant systems in various conditions.

1. Water Quality in HVAC Hydronic Systems: An International Review (CH-24-C117)

Amr Suliman, PhD, Full Member¹, Mahroo Eftekhari, CEng, Full Member², Vanda Dimitriou, Associate Member², Darren Wilkinson, Member³ and Enea Dimitris Tseno, Associate Member², (1)University of Oxford, Loughborough, United Kingdom, (2)Loughborough University, Loughborough, United Kingdom, (3)Vexo International, United Kingdom

2. Thermally Anisotropic Building Envelope Integration into Panelized Metal Construction: Laboratory Evaluation and Numerical Study (CH-24-C118)

Daniel Saleem Howard, Student¹, Som S Shrestha, Full Member¹, Zhenglai Shen, Associate¹, Andre O Desjarlais, Program Manager¹, Robert Zabcik² and Diana Hun¹, (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)Z-tech Consulting LLC

3. Energy Efficiency of Radiant Heating/Cooling: Test Laboratory (CH-24-C119)

Dusan Petras, Professor, Full Member, Slovenska spolocnost pre techniku prostredia, Bratislava, Slovakia

9:45 AM - 10:45 AM

Seminar 56 (Intermediate)

15°F Chilled Water Delta T in Standard 90.1: Its Impact on Design Practices and Equipment

Track: HVAC&R Systems and Equipment



Room: Great Lakes B

Sponsor: 8.2 Centrifugal Machines

Chair: Raymond W Good Jr, P.E., Full Member, Danfoss, Palmyra, VA

The 2016 version of 90.1 introduced a design requirement for cooling coils to have a minimum of a 15°F temperature difference and leaving-water temperature to be no less than 57°F. This represents a significant departure from the industry standard of 10°F which had been a default for decades. This seminar reviews the intent and details of this new requirement and implications of conforming to it. The impact on design, controls and equipment including cooling coils, air delivery systems, pumps, piping systems and chillers will be explored.

1. 90.1 Minimum Chilled Water Delta T: Rationale and Impact on Distribution System Design

Steven T Taylor, PE, Fellow Life Member, Taylor Engineering LLC, Alameda, CA

2. 90.1 Minimum Chilled Water Delta T: Equipment Impacts and Technology

Sarah Hilden, Associate, Trane, Onalaska, WI

3. Heat Exchanger Design Optimization for Enhanced Energy Efficiency in Higher Chilled Water Delta T Systems

Gregory Touron, Danfoss Heat Exchangers, Z.I de Reyrieux, Reyrieux, France

9:45 AM - 10:45 AM

Seminar 57 (Intermediate)

An Exploration of Guideline 10's Potential for Achieving Coordinated Indoor Environmental Requirements and Project Completion

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Water Tower A

Sponsor: SGPC10

Chair: Carl Grimes, HHS CIEC, Full Member, Hayward Healthy Home, Denver, CO

Indoor Air Quality (IAQ) is but one factor of indoor environmental quality (IEQ): thermal, acoustical, illumination, IAQ. ASHRAE addresses all four factors, but separately and ad hoc, easily resulting in conflicts and contradictions. The multiple Factors of IEQ inherently requires a coordinated framework. Speaker 1 extends the IAQ details of Standards 62 and 241 outward to the ROI of better IEQ. Speaker 2 begins outside IEQ with community data and weatherization, working inwards to IEQ and its ROI. Speaker 3 will integrate each into the structure of Guideline 10 as examples of resolving fragmentation and lack of consistent project coordination.

1. Costs and Benefits of Particle Filtration in Commercial Spaces

Richard Bruns, Economist of Public Health, The Johns Hopkins Center for Health Security, Baltimore, MD

2. The Role of Housing in Health: Identifying Benefits through Public Health

Kevin Kennedy, MPH, Children's Mercy Kansas City, Kansas City, MO

3. Two Examples of How the Framework of ASHRAE Guideline 10 Can Better Structure and Coordinate Current ASHRAE Tasks and Projects

Carl Grimes, HHS CIEC, Full Member, Hayward Healthy Home, Denver, CO

9:45 AM - 10:45 AM

Seminar 58 (Intermediate)

Strategies for Net Zero Energy Buildings

Track: Decarbonization and Climate Change



Room: Great Lakes C

Sponsor: 6.7 Solar and Other Renewable Energies, 2.8 Building Environmental Impacts and Sustainability

Chair: Svein O Morner, Full Member, HGA, Inc, Middleton, WI

Buildings' energy consumption is a major factor driving global warming and designing and constructing Net Zero Energy (NZE) buildings is required to reduce the rate of climate change. This seminar explores how NZE buildings can be designed even for cold climates and how these buildings can not only impact but also support the electrical infrastructure as the number of NZE buildings increase. This session also discusses how these facilities can actively manage their energy consumption by incorporating battery technologies and even charge or discharge electrical vehicles at strategic times.

1. Designing Net-Zero Energy Buildings

Svein O Morner, Full Member, HGA, Inc, Middleton, WI

2. Capturing the Potential of Distributed Energy Resources for Grid Transformation

Veronique Delisle, Ing., Ph.D., Natural Resources Canada, Varennes, QC, Canada

3. Solar PV and Electric Vehicles Together: A True Sustainable Approach

Khalid Nagidi, BEAP, Full Member, EMCG, WANTAGH, NY, United States

9:45 AM - 10:45 AM

Seminar 59 (Intermediate)

What's the Fuss about Zero Trust Cyber Security for BAS Control Systems

Track: HVAC&R Systems and Equipment



Room: Water Tower B

Sponsor: MTG.CYB, 1.4 Control Theory and Application , TC 7.5

Chair: Carol Lomonaco, Full Member, Johnson Controls, Milwaukee, WI

Zero Trust (ZT) is an emerging concept in cybersecurity which is a security model designed to enhance the depth and breadth of cybersecurity design principles within IT systems. ZT uses a set of design principles and system management approach that recognizes threats are more sophisticated than ever before. Traditional approaches to cybersecurity such as defense-in-depth are no longer sufficient to prevent or deter threats that seek to leverage system vulnerabilities. Building Automation Systems (BAS) Systems are often isolated systems that were never designed with cybersecurity in mind which have exposed these systems to the cybersecurity dangers faced by traditional IT.

1. From Naive to Paranoid: Zero Trust Cybersecurity Concepts Unleashed

Ecton English, Full Member, National Security Agency, Fort George Meade, MD

2. Can Zero Trust Be Applied to BAS Control Systems?

Jim Walters III, CISSP, USACE Federal Building Room 968, Louisville, KY

9:45 AM - 10:45 AM

Workshop 2 (Intermediate)

Planned and Unplanned Pathways in Buildings and Its Influence on Ventilation, IAQ and Air Delivery

Track: Ventilation, Indoor Air Quality and Air Distribution Systems



Room: Great Lakes E

Sponsor: 1.12 Moisture Management in Buildings

Chair: Donald B Snell, P.E., Full Member, Liberty Building Forensics Group, Longwood, FL

Adequately designed, installed, and maintained air pathways are imperative to help ensure healthy, comfortable and energy-efficient buildings. However, there are different types of air management problems that occur, which may result in detrimental impacts. This seminar discusses shortcomings of some commonly designed air pathways as well as negative impacts from unplanned pathways in buildings. Past research and forensic investigations of moisture damage, poor indoor air environment control, and high energy use will be used to demonstrate how to avoid problems associated with different types of unbalanced air, duct leakage, envelope design and different ventilation and energy management controls.

1. Air Pathways in Buildings, the Next Covered Peril: Airflow Occurrences and Unexpected Claims in Multi Family Design and Construction

Donald B Snell, P.E., Full Member, Liberty Building Forensics Group, Longwood, FL

2. Air Quality, Comfort and Energy Impacts Associated with Unbalanced Airflow

Charles R. Withers, Research Analyst, University of Central Florida, ORLANDO, FL

Wednesday, January 24, 11:00 AM - 12:30 PM

Paper Session 31

Advancements in Fluid Flow Measurement, Lunar Energy Harvesting, Urban Building Energy Modeling and Real-Time HVAC Control

Track: Fundamentals and Applications



Room: Great Lakes F

Chair: Som S Shrestha, Full Member, Oak Ridge National Laboratory, OAK RIDGE, TN

This session explores developments in areas of engineering and sustainability. The first presentation delves into the Equal Area, Log-Linear, and Log-Tchebycheff rules for fluid flow measurement, uncovering assumptions and practical implications. The second focuses on a novel thermoelectric energy harvesting system for lunar habitation, capitalizing on the extreme temperature

gap on the moon. The third offers an empirical validation of Urban Building Energy Modeling (UBEM) for Chicago, assessing biases and limitations to inform best practices. Lastly, the fourth examines the use of computer vision for a method for dynamic internal and solar gains detection to optimize energy efficiency in buildings.

1. The Equal Area, Log-Linear and Log-Tchebycheff Rules: Derivations and Assumptions (CH-24-C120)

Conor Fleming, P.Eng., Coanda Research and Development Corporation, Burnaby, BC, Canada

2. Development of Thermoelectric Energy Harvesting System for the Lunar Habitation (CH-24-C121)

Seheon Kim, Student¹, Hansol Lim², Sanghwan Park¹ and Jae-Weon Jeong, Member¹, (1)Hanyang University, Seoul, Korea, Republic of (South), (2)Korea Institute of Civil Engineering and Building Technology, Goyang, Korea, Republic of (South)

3. Empirical Validation of UBEM: An Assessment of Bias in Urban Building Energy Modeling for Chicago (CH-24-C123)

Ankur Garg¹, Santiago Correa¹, Fengqi Li², Shovan Chowdhury³, Joshua New, Ph.D., Full Member², Christa Brelsford², Kevin Bacabac¹, Christian Kunkel¹ and Donnel Baird¹, (1)BlocPower, Brooklyn, NY, (2)Oak Ridge National Laboratory, Oak Ridge, TN, (3)University of Tennessee, Knoxville, TN

11:00 AM - 12:30 PM

Paper Session 32

Energy Efficiency in Cooling Systems

Track: HVAC&R Systems and Equipment



Room: Great Lakes G

Chair: Ahmed Elatar, Oak Ridge National laboratory, Associate, Oak Ridge National Laboratory, OAK RIDGE, TN

This session focuses on ways to achieve energy efficiency in cooling systems. The first presentation examines the impact of retrofitting a data center with extra cooling systems to increase the cooling capacity; the second explores the potential of waste heat recovery in data centers through a heat exchanger; the third simulates the operation of a liquid desiccant-based dehumidification system using trained neural networks representing an internally cooled dehumidifier and regenerator to reduce heating and cooling loads; and the last highlights the results of tests performed on a prototype cooler.

1. Retrofitting a Data Center at the University to Enhance Energy Efficiency (CH-24-C125)

Nitesh Singh, Student¹, Indra Permana, Student² and Fujen Wang, Ph.D., P.E., Fellow ASHRAE¹, (1)National Chin-Yi University of Technology, Taichung, Taiwan, (2)National Chin-Yi University of Tech, WALNUT, CA

2. Waste Heat Recovery from Data Center Cooling System for District Heating Network (CH-24-C126)

Seungmin Jang, Student and Jinkyun Cho, Full Member, Hanbat National University, Seoul, South Korea

3. Transient Modeling for an Internally Cooled Liquid Desiccant Air Dehumidification System Using Artificial Neural Networks (CH-24-C127)

Tomas Pablo Venegas, BEMP, Associate and Ming Qu, PhD, Full Member, Purdue University, West Lafayette, IN

4. Desiccant Enhanced Indirect Evaporative Cooling: Laboratory Testing and Practical Application Savings Modeling (CH-24-C128)

Jonathan Hollist, Full Member, Robert McMurry and David R Vernon, PhD, Full Member, Western Cooling Efficiency Center, UC Davis, Davis, CA

11:00 AM - 12:30 PM

Seminar 60 (Intermediate)

Applications and Benefits of Liquid Desiccant Technology in Dedicated Outdoor Air Systems

Track: HVAC&R Systems and Equipment



Room: Great Lakes C

Sponsor: 8.10 Mechanical and Desiccant Dehumidification Equipment, Heat Pipes and Components

Chair: Onieluan Tamunobere, Ph.D., P.E., Full Member, Heat Pipe Technology, Tampa, FL

In this seminar, the applications and benefits of liquid desiccant technology in controlling humidity in Dedicated Outdoor Air Systems (DOAS) is presented. Theoretical performance of an alternative system involving an ionic liquid (IL) membrane-based desiccant dehumidification system is presented. A practical case study of an ongoing new liquid desiccant dedicated outdoor air system (LD-DOAS) for the Department of Defense (DoD) is also presented. Finally, a novel liquid desiccant Dedicated Outdoor Air System (DOAS) capable of using the energy storage potential of liquid desiccants to shift the electricity required for air conditioning from on-peak hours to off-peak hours is presented.

1. Increasing the Moisture Removal Efficiency of a Direct-Expansion Dedicated Outdoor Air Systems

Andy Lowenstein, Ph.D., Member, AIL Research, Inc, Princeton, NJ

2. Semi-Open Ionic Liquid Desiccant Dehumidification Cycle for Energy-Efficient Treatment of Ventilation Air in Hot and Humid Climate Hospitals

Saeed Moghaddam, Ph.D., Full Member, University of Florida, GAINESVILLE, FL

3. Demonstration of a 10-Ton Liquid Desiccant DOAS for the DoD at the Naval Air Station, Key West

Eric J Kozubal, Full Member, National Renewable Energy Laboratory (NREL), Golden, CO

4. Energy Storage and Load Shifting Using Novel Liquid Desiccant DOAS

Matt Tilghman, Ph.D., Associate, Blue Frontier, Inc., Boca Raton, FL

11:00 AM - 12:30 PM

Seminar 61 (Intermediate)

Challenges, Opportunities and Lessons Learned in Controlled Environment Agriculture

Track: Decarbonization and Climate Change



Room: Great Lakes B

Sponsor: 2.2 Plant and Animal Environment, 7.5 Smart Building Systems , MTG CEA

Chair: Liping Wang, PhD, S-B-a Member, University of Wyoming, LARAMIE, WY

The world's population is expected to rise to nearly 10 billion, global food demand will increase by 56%, the agriculture land gap is 593 million-hectare, and the greenhouse gas (GHG) mitigation gap is 11-gigaton by 2050. Controlled environment agriculture (CEA) provides a potential solution to these grand challenges through year-round crop production, high yields, reduced water usage, few pesticides, and the ability to grow crops in areas with unfavorable climates or in face of climate risks. This seminar discusses the current challenges, opportunities, and standards in the CEA industry. The speakers present the lessons learned through case studies.

1. Trimming Energy Use in Controlled Environment Horticulture Facilities through Building Energy Codes

Diana Burk, Member, Energy Solutions, Decatur, GA

2. Energy Performance Evaluation and Modeling for an Indoor Farming Facility

Liping Wang, PhD, S-B-a Member, University of Wyoming, LARAMIE, WY

3. Finding the Competitive Edge in Cultivation: Putting Science and Data to Work

Adrian B Giovenco, Full Member, InSpire Transpiration Solutions, Berkeley, CA

11:00 AM - 12:30 PM

Seminar 62 (Intermediate)

Digital Twins for Building Design and Operation

Track: Comfort, Indoor Environmental Quality and Energy Efficiency



Room: Water Tower A

Sponsor: 4.10 Indoor Environmental Modeling

Chair: Michael J Carl, P.Eng, Full Member, RWDI, Toronto, ON, Canada

A digital twin is a computational model of a building or space. It allows for the testing and improving of both the design and operation of a high-performance space. This seminar looks at a variety of digital twin applications including data centers, ultra-efficient buildings, and education facilities with occupant controls. It explores how digital twins are created/implemented and their in role improving thermal comfort, energy efficiency and operational performance.

1. Assessing Thermal Comfort of a Personalized Comfort System Using Digital Twins

Mohammad Heidarinejad, Ph.D., P.E., S-B-a Member, Saeed Farhoodi, Student and Saman Haratian, Student, Illinois Institute of Technology, Chicago, IL

2. Modeling an Ultra-Efficient Office Building with Coupled Energyplus-Modelica Models

Xu Han, PhD, Full Member, University of Kansas, LAWRENCE, KS

3. Digital Twins for Data Center Whitespace Cooling

James W VanGilder, PE, Full Member, Snider Electric

4. Operating a Data Center Using a Digital Twin

Mark James Seymour, P.E., Full Member, Cadence Design Systems, Wincanton, United Kingdom

11:00 AM - 12:30 PM

Seminar 63 (Basic)

LIVESTREAM: Hot Off the Press! ASHRAE TC 9.9 Liquid Cooling Publication

Track: Hydronic Systems



Room: Great Lakes A

Sponsor: 9.9 Mission Critical Facilities, Data Centers, Technology Spaces and Electronic Equipment

Chair: Eric Yang, PE, Full Member, Vantage Data Center, Vienna, VA

Since its initial publication, *Liquid Cooling Guidelines for Datacom Equipment Centers* has provided equipment manufacturers and facility operations personnel with a common set of guidelines for various liquid cooling strategies focusing on the requirements for both the Technology Cooling System and Facility Cooling System. In this seminar we will give a preview of the forthcoming 3rd Edition of the publication. We will cover everything from the latest power trends driving the adoption of liquid, the variety of IT server cooling technologies, and the considerations when designing a facility for liquid cooling.

1. What's Driving the Interest in Liquid Cooling?

Mark Steinke, Member, Nvidia, Austin, TX

2. The Technology Cooling System (TCS) Loop and Its Technology Solutions

Dustin W Demetriou, PhD, Full Member, IBM, Hyde Park, NY

3. The Facility Water System (FWS) and Considerations for Delivering Liquid Cooling

Dustin W Demetriou, PhD, Full Member, IBM, Hyde Park, NY

11:00 AM - 12:30 PM

Seminar 64 (Intermediate)

The Opportunity and Energy Density Challenge of Lithium Ion Battery Dry Cleanrooms in Climate Rebalancing and Carbon Reduction from Fossil Fuels

Track: Labs, Clean Spaces and Mission Critical Facilities



Room: Great Lakes E

Sponsor: 9.11 Clean Spaces

Chair: Roland Charneux, Life Member, Pageau Morel & Associes, Montreal, Canada

The demand for LI (Lithium Ion) batteries (EVs and Storage) is growing rapidly as the adoption of electric vehicles increases along with energy storage for an alternative green energy power source and load balancing, during peak times. This growth is driven by several factors, including the move to climate rebalancing and carbon reduction, with increasing concerns about climate change, the falling cost of electric vehicle batteries, and government incentives and subsidies for electric vehicles and energy storage. The benefit is lower carbon emissions and a significant reduction in fossil fuels used for transportation.

1. Role of Li Battery Technology in Climate Rebalancing and the Drive to Net Zero Carbon Emissions.

Vincent A Sakraida, PE, LEED AP, Full Member, Fluor, Evansville, IN

2. Background and Context of Li Battery Technology for EVs and Storage Systems for Net Zero Carbon Emissions.

Conor Murray, BE (Elec) MIE, Full Member, 3dimension Cleanrooms Limited, Baldoyle, Ireland

3. How Demand Based HVAC Systems and Adaptive Controls Can Minimize the Energy Density of Dry Cleanrooms Systems

Conor Murray, BE (Elec) MIE, Full Member, 3dimension Cleanrooms Limited, Baldoyle, Ireland