



2024 ASHRAE Annual Conference

June 22nd - June 26th, 2024

Sunday, June 23

Sunday, June 23, 8:00 AM - 9:00 AM

Conference Paper Session 1 (Basic)

Developing Modeling Approaches for Energy Performance Evaluation

Track: Research Summit

Room: Grand Ballroom 9

Chair: Patrick E Ryan, Full Member, Hanson Professional Services, Springfield, IL

Papers in the session describe the use of models to quantify energy savings and system performance in radiative cooling, power shedding and agricultural applications.

1. Using Urban Building Energy Modeling to Quantify the Energy Saving Potential for Radiative Cooling (IN-24-C001)

Zhaoru Liu, Fan Bu and Da Yan, Ph.D., Full Member, Building Energy Research Center, School of Architecture, Tsinghua University

2. Performance of Baseline Models for Power Shed Estimation on Campus Buildings (IN-24-A001)

Yashvi Malhotra, Research Assistant, Student¹ and Jordan D. Clark, PhD, S-B-a Member², (1)Ohio State University, COLUMBUS, OH, (2)The Ohio State University, Lewis Center, OH

3. Modelling Temperature Dynamics of a Swine Barn Using Genetic Algorithm Based Gray Box Modelling (IN-24-A002)

Rawisha Serasignhe, Research Associate, Student¹ and Jordan D. Clark, PhD, S-B-a Member², (1)The Ohio State University, Columbus, OH, (2)The Ohio State University, Lewis Center, OH

8:00 AM - 9:00 AM

Conference Paper Session 2 (Basic)

Applications in Energy Efficiency and Resilience

Track: Research Summit



Room: Grand Ballroom 10

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

Presentations in this session describe recent work in building modeling and controls can advance efficiency and resilience of buildings and manufacturing processes.

1. Smart Building Pillars (IN-24-C002)

Ryan Alexander Casey, Full Member, Cisco Systems, BONITA SPRINGS, FL, United States

2. Energy Efficiency in Coastal Climates: Unravelling Design Sensitivities (IN-24-C003)

Nazanin Azimi Fereidani, Eng, Student¹, Eugénio Rodrigues, Assistant Professor² and Adélio Gaspar, Associate Professor, Associate Member², (1)University of Coimbra/ADAI-VAT 502550554, Coimbra, Portugal, (2)University of Coimbra, Coimbra, Portugal

3. Enhancing Resilience and Sustainability for Small Manufacturing Enterprises in Southern Illinois (IN-24-C004)

Raman Budhathoki, Graduate Student, Student¹ and James A Mathias, PE, Full Member², (1)Southern Illinois University, Carbondale, IL, (2)Southern Illinois University, CARBONDALE, IL

8:00 AM - 9:00 AM

Seminar 1 (Basic)

ASHRAE Conference Crash Course

Track: Fundamentals and Applications

Room: Grand Ballroom 2

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 when do all the events happen? 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

Ben Oliver, P.Eng, Member, Sault College of Applied Arts and Technology, Sault Ste. Marie, ON, Canada

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

Blake Forsythe, Associate, Hobbs & Associates, Inc

3. Make the Most of Your Conference Experience

Keiron Dharmanash Nanan, S-B-a Member, Temp Tec Limited, Trinidad and Tobago

8:00 AM - 9:00 AM

Seminar 2 (Intermediate)

LIVESTREAM: Electrifying the Future: Decarbonization Strategies for the Built Environment

Track: Electrification: Possibilities and Pitfalls



Room: Grand Ballroom 4

Sponsor: 6.7 Solar and Other Renewable Energies

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

This seminar aims to explore the critical role of electrification in achieving decarbonization objectives within the built environment. It covers the spectrum of electrification-enabling technologies, emphasizing their potential to significantly reduce reliance on fossil fuels and minimize carbon emissions. The focus will be on exploring a variety of solutions, including the implementation of renewable energy sources and the integration of sustainable technologies into building design and operations.

1. Commercial Solar Lighting Systems and Their Contribution to Decarbonization Goals

Khalid Nagidi, BEAP, Full Member, EMCG, WANTAGH, NY, United States

2. Equitable Urban Renewable Energy Integration through Planning and Simulation

Fengqi Li, Associate Member, Oak Ridge National Laboratory, Oak Ridge, TN

8:00 AM - 9:00 AM

Seminar 3 (Intermediate)

Wildfires and Their Effect on Building Occupant Health

Track: Legislation, Standards, Codes, and Guidelines



Room: Grand Ballroom 3

Sponsor: 2.5 Global Climate Change, 2.4 Particulate Air Contaminants and Particulate Contaminant Removal Equipment , working on EHC

Chair: Scott Sherwood, Full Member, Eco Care Corporation, NEW YORK, NY

The 2023 wildfires illustrated how vulnerable our buildings are from contamination, with life safety being a major concern. Are there new guidelines, codes and standards being developed for design engineers and facility operators to follow in order to safeguard their facilities and minimize risk? Is there data available how these buildings operated and the issues the wildfires caused?

1. Wildfire-Resilient Mechanical Ventilation Systems for Single-Detached Homes in Cities of Western Canada

Lexuan Zhong, PhD, S-B-a Member, University of Alberta, Edmonton, Canada

2. How Can Filtration and ASHRAE Guidelines Provide Guidance to Protect Building Occupants from Effects of Wildfires

Kathleen Owen, Fellow Member, Owen Air Filtration Consulting, Cary, NC

3. You Didn't Need to Wait until the Wildfire Reached Your Air Intakes! Air Monitoring Is Here

Dinesh Wadhwani, ThinkLite, Natick, MA

8:00 AM - 9:00 AM

Forum 1 (Basic)

Basics of Air Change Rates

Track: Fundamentals and Applications

Room: Grand Ballroom 1

Sponsor: MTG.ACR Air Change Rate, 9.11 Clean Spaces , 9.10 Laboratory Systems

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

The supply airflow requirements for healthcare, cleanrooms, and laboratories facilities are often specified as Air Change Rates (ACR). Over the years several notions have been developed about ACR. This forum will systematically evaluate validity of popular notions regarding the ACR. The main objective of this session is to provide basic principles of air change rates. It will demonstrate where ACR may be the appropriate metric and what other factors that designers of ventilation systems should consider. Attendees are encouraged to bring their laptops and use Excel spreadsheets to test various scenarios to test the impact of ACR on various parameters.

8:00 AM - 9:00 AM

Workshop 1 (Basic)

Machine Learning Foundations: Intro to Data Science Tools for Building Industry Professionals

Track: Artificial Intelligence and the Built Environment



Room: Grand Ballroom 7

Sponsor: 7.5 Smart Building Systems

Chair: Greg Pavlak, Ph.D., Member, The Pennsylvania State University, University Park, PA

Building systems are producing enormous amounts of data. Converting that data into knowledge and action, and keeping up with advancements in artificial intelligence, requires foundational knowledge in modern data science methods and machine learning tools. This workshop will present interactive live coding and analysis examples to help building industry professionals develop and expand their data wrangling and analysis skills. Potential application examples include: building automation system data cleaning and analysis, performance prediction and fault detection, and measurement and verification.

The code examples can be accessed at: <https://github.com/gpavlak/ashrae-ml-fdn> . Please come prepared to discuss your building data questions and challenges!

1. Regression Techniques for Measurement and Verification from Building Automation and Interval Meter Data

Greg Pavlak, Ph.D., Member, The Pennsylvania State University, University Park, PA

2. Machine Learning Techniques for Data-Driven Modeling of Commercial Building HVAC Systems

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

8:00 AM - 9:00 AM

Workshop 2 (Intermediate)

Project Scheduling: Rules and Basics of Pull Planning

Track: Workforce Development



Room: Grand Ballroom 8

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

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

Pull planning helps teams succeed by providing mutual accountability based on trust to create a project schedule. It does not matter if you are in design or construction, pull planning is a great tool to develop a schedule based on needs of others rather than arbitrary milestones. This workshop will review the fundamentals of pull planning followed by an interactive pull planning session for attendees to learn by doing. Prepare yourself for future projects by having this tool in your toolbox.

1. Pull Planning Basics

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

Sunday, June 23, 9:45 AM - 10:45 AM

Debate 1 (Basic)

Radiant vs Air vs VRF: Debating Decarbonization Design Alternatives

Track: HVAC&R Systems and Equipment

Room: Grand Ballroom 3

Sponsor: 6.5 Radiant Heating and Cooling, 5.3 Room Air Distribution

Chair: Jonathan Woolley, PhD, Full Member, Emanant Systems, COLRAIN, MA, Ryan Westlund, Baumann Consulting, DC, Glenn Friedman, PE, Fellow Life Member, Taylor Engineers, Alameda, CA, Matt Bhumbra, Full Member, Price Industries, Suwanee, GA and Carlos Duarte, Ph.D., Associate, UC Berkeley, Center for the Built Environment, Berkeley, CA

What is the best system design strategy to decarbonize buildings? In this dynamic debate, experts weigh the strengths and tradeoffs for radiant, air and VRF systems with regard to today's critical design objectives including: all-electric operation, efficiency, cost, indoor air quality, occupant comfort, safety, maintainability, electric demand flexibility and lifecycle emissions. Experts present innovative solutions grounded in research, case studies, and design experience - and together we will navigate the complexities of high performance building design.

9:45 AM - 10:45 AM

Conference Paper Session 3 (Basic)

Occupant and Building Interaction

Track: Research Summit

Room: Grand Ballroom 9

Chair: Stephanie Kunkel, PE, Full Member, JMT, COCKEYSVILLE, MD, United States

Occupants rely on buildings to provide comfort, while also impacting their operation. This session explores the use of sensors, occupant-centric retrofit assessments and occupant response to ventilation to address both issues.

1. Feasibility of Use of Auto-Calibrated CO2 Sensors in Rural Alaskan Homes through Long-Term CO2 Data Analysis (IN-24-C005)

Cassandra Calliope Conrad, Michigan State University, East Lansing, MI

2. Towards Occupant-Centric Building Retrofit Assessments: An Integrated Protocol for Real-Time Monitoring of Building Energy Use, Indoor Environmental Quality, and Enclosure Performance in Relationship to Occupant Behaviors (IN-24-C006)

Shayan Mirzabeigi, Student¹, Sameeraa Soltanian-Zadeh, Student Member², Bess Krietemeyer², Bing Dong, Ph.D., S-B-a Member², Nina Wilson, PhD², Brian Carter² and Jianshun Zhang², (1)Syracuse University, SYRACUSE, NY, (2)Syracuse University, Syracuse, NY

3. Occupant Response to Changes to Ventilation Rate in a Controlled Environment (IN-24-A003)

Troye Isasiah Sas-Wright, Student¹, Harrison Fried², Jordan D. Clark, PhD, S-B-a Member² and Sreenand Sreedevi, Student², (1)The Ohio State University, Columbus, OH, (2)The Ohio State University, Lewis Center, OH

9:45 AM - 10:45 AM

Conference Paper Session 4 (Basic)

AI-Driven Energy Management

Track: Research Summit



Room: Grand Ballroom 10

Chair: Amr Suliman, PhD, Full Member, University of Oxford, Loughborough, United Kingdom

Investigating AI-driven energy management, these papers explore explainable AI frameworks, fast demand response using model predictive control, and scaling data-driven building energy modeling with large language models.

1. Explainable AI Framework for Model Predictive Control in Energy Management Systems (IN-24-C007)

Ken Takahashi, PE, Student¹, Ryozo Ooka, PhD, Fellow Member² and Hiroyuki Ichikawa, Student¹, (1)University of Tokyo, Tokyo, Japan, (2)IIS University of Tokyo, Tokyo, Japan

2. Fast Demand Response Based on Model Predictive Control for a Net Zero Energy Building in Cold Climate (IN-24-C008)

Hiroyuki Ichikawa, Student¹, Ryozo Ooka, PhD, Fellow Member² and Ken Takahashi, PE, Student¹, (1)University of Tokyo, Tokyo, Japan, (2)IIS University of Tokyo, Tokyo, Japan

3. Scaling Data-Driven Building Energy Modelling using Large Language Models (IN-24-C009)

Sunil Khadka, Student¹ and Liang Zhang, Assistant Professor, Associate², (1)University of Arizona, Tucson, (2)The University of Arizona, Tucson, AZ

9:45 AM - 10:45 AM

Seminar 4 (Intermediate)

Germicidal Ultraviolet (GUV) Disinfection for Energy Savings, Decarbonization, and Healthier Buildings

Track: Research Summit



Room: Grand Ballroom 1

Chair: Cary Faulkner, Student, Pacific Northwest National Laboratory, Boulder, CO

Providing good indoor air quality (IAQ) in buildings is a critical priority with impacts to public health, education outcomes, and climate change. Organizations such as ASHRAE have recently developed new building design standards to improve IAQ that could also significantly impact building energy use and carbon emissions. Evidence indicates that germicidal ultraviolet (GUV) technologies combined with ventilation may be more energy-efficient and effective than ventilation strategies alone to meet the new standards. This seminar provides an overview and shares new findings of ongoing U.S. Department of Energy research and development of GUV technologies to meet new building IAQ standards.

1. An Overview of Ongoing U.S. DOE Research of Germicidal Ultraviolet (GUV) Disinfection Technologies

Gabe Arnold, Full Member, Pacific Northwest National Laboratory, Burlington, VT

2. Quantifying the Contribution of Germicidal Ultraviolet Systems Towards Meeting ASHRAE 241 Standard Based on in-Situ Measurements

Belal Abboushi, PNNL, RICHLAND, WA, United States

3. Comparison of Effectiveness and Energy Use of Airborne Pathogen Mitigation Measures to Meet Clean Air Standards

Cary Faulkner, Student, Pacific Northwest National Laboratory, Boulder, CO

9:45 AM - 10:45 AM

Seminar 5 (Intermediate)

Laboratory Standards and Codes Updates

Track: Legislation, Standards, Codes, and Guidelines



Room: Grand Ballroom 2

Sponsor: 9.10 Laboratory Systems, 7.6

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

This seminar reviews recent changes to NFPA 45 2024, Title 24 2025, and ANSI Z9.5 2022 with their impact to Laboratory systems and Lab space design. Expanded scope and clarifications in NFPA 45 now align with NFPA 30. This talk reviews updates to Z9.5 and how it aligns to ASHRAE Standard 110. Title 24 2025 now includes performance standards for laboratory exhaust.

1. Significant Modifications to NFPA 45 2024, Standard on Fire Protection for Laboratories Using Chemicals

Kenneth W Crooks, Full Member, New England Laboratory Casework Co., Woburn, MA

2. Changes in the 2025 California Title 24 Energy Code

Brad C Cochran, Full Member, C P P Inc, Windsor, CO

3. ANSI/ASSP Z9.5 Laboratory Ventilation 2022 Version and a Look Ahead

James J Coogan, PE, Life Member, Siemens Building Technology, JACKSONVILLE, FL

9:45 AM - 10:45 AM

Seminar 6 (Intermediate)

LIVESTREAM: Present and Future Weather For Design and Resilience

Track: Research Summit



Room: Grand Ballroom 4

Sponsor: 2.5 Global Climate Change

Chair: Elizabeth Jedrlnic, Full Member, Trane, SAN JUAN, PR

Climate change is making it necessary to use newer sources of weather data for proper design of HVAC&R equipment in buildings. In addition, estimations of weather for future conditions also are needed to evaluate resilience of building systems due to climate change.

This seminar provides a talk focused on application of weather data properly to present conditions. It then turns to a case study that uses stochastic future weather conditions for an assessment for a resilience hub and microgrid.

1. Climate and Weather Data: Availability and Challenges

Drury B Crawley, PhD, BEMP, Fellow Life Member, Bentley Systems, Inc., Washington, DC

2. Reducing HVAC Loads for Future Conditions of a Hawai'ian Resilience Hub and Microgrid

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

9:45 AM - 10:45 AM

Seminar 7 (Intermediate)

The Why and the How of Geothermal Exchange: A Key Strategy for Cold Climate Electrification

Track: Electrification: Possibilities and Pitfalls



Room: Grand Ballroom 7

Chair: Mosope A Ismail, Senior Mechanical Engineer, Associate, SmithGroup, Detroit, MI

This session presents on Geothermal Exchange, the "Why" – overlaying water and air source heat pump efficiencies with power grid carbon intensities to explain why water source heat pumps make so much sense in cold climates, and The "How" - sharing practical considerations for design engineers informed by the knowledge and expertise of a drilling contractor.

1. Overlaying Heat Pump Efficiencies with Power Grid Carbon Intensities to Make the Case for Geothermal Exchange

Nancy W Kohout, Professional Engineer, Full Member, SmithGroup, WASHINGTON, DC

2. The "How" of Geothermal Exchange: Design Considerations from the Driller's Perspective

Kortney Lull, Associate, Midwest Geothermal, Grand Rapids, MI

9:45 AM - 10:45 AM

Workshop 3 (Basic)

Creating a Competitive Advantage by Leveraging Company Culture

Track: Workforce Development



Room: Grand Ballroom 8

Sponsor: 1.7 Business, Management & General Legal Education, Board DEI Subcommittee, YEA Committee

Chair: Keiron Dharmanash Nanan, S-B-a Member, Temp Tec Limited, Trinidad and Tobago

Studies show that diverse companies can outperform their competition. This workshop is designed to equip participants with strategies to foster a lasting culture of diversity and inclusion within their organizations. We will discuss how to leverage a current workforce and identify opportunities for growth. Participants will leave this interactive workshop with an action plan centered around one of two possible topics: Diversity, Equity, and Inclusion Plan or Mentorship Program, enabling them to take tangible steps towards creating a more inclusive and equitable workplace environment.

1. Leveraging Company Culture

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

2. Creating Your Action Plan

Madison W Schultz, PE, Full Member, ADG|Blatt, Oklahoma City, OK

Sunday, June 23, 11:00 AM - 12:30 PM

Debate 2 (Basic)

LIVESTREAM: 2023-2024 ASHRAE Decarbonization Challenge: Project Review

Track: Fundamentals and Applications

Room: Grand Ballroom 4

Sponsor: YEA Committee

Chair: Zachary Alderman, PE, Full Member, Cambio AI, Belmont, NH, Elise Kiland, PE, Member, CMI, Austin, TX, Madison W Schultz, PE, Full Member, ADG|Blatt, Oklahoma City, OK and Elizabeth Jedrlinic, Full Member, Trane, SAN JUAN, PR

Presenters from each team awarded a Decarbonization Challenge Grant summarize the scope of their project, provide an update on the results of the project to date and share lessons learned and where any open source resources from the project can be accessed.

11:00 AM - 12:30 PM

Conference Paper Session 5 (Basic)

Ventilation and Indoor Air Quality

Track: Research Summit



Room: Grand Ballroom 10

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

This session explores different aspects of ventilation and IAQ in hospital and higher education setting as well as methods and equipment for promoting IAQ.

1. CFD Analysis of Ventilation Performance of the Hospital Post Anesthesia Care Unit (PACU) (IN-24-C010)

Kishor K Khankari, PhD, Fellow Member¹, Alberto Garcia, Mechanical Engineer², Leonid Turkevich, Ph.D., Senior Service Fellow² and Kevin H Dunn, Sc.D., CIH, Research mechanical engineer², (1)AnSight LLC, Ann Arbor, MI, (2)National Institute for Occupational Safety and Health (NIOSH), Cincinnati, OH

2. Clearing the Air: A Case Study Exploring Indoor Air Quality in a Higher Education Construction Lab (IN-24-C011)

Joseph Ryan Manuel, MBA, LEED® Green Associate™, Full Member, Deniz Besiktepe, Ph.D., Anthony E. Sparkling, Ph.D. and Nathan Thomas Gick, Purdue University - Construction Management, West Lafayette, IN

3. A Method of Operating the Opening Ratio of Natural Ventilation Openings Focused on Indoor Thermal Environment and Indoor Air Quality (IN-24-C012)

Kei Shimonosono, Dr.Eng, Associate¹ and Yuji Sasaki², (1)National Institute of Public Health, Wako, Japan, (2)Hokkaido Research Organization, Asahikawa, Japan

4. ASHRAE Standard 241 and Graphene Silver-Coated Merv-a 9-a Filters: A Case Study (IN-24-A004)

Deepak Sridhar, PhD, PEng, Associate¹, Kathleen Owen, Fellow Member², Ryan Shacklock, Associate Member³ and Colin van der Kuur, Associate Member³, (1)Zentek Ltd, Guelph, ON, Canada, (2)Owen Air Filtration Consulting, Cary, NC, (3)Zentek Ltd., Guelph, ON, Canada

11:00 AM - 12:30 PM

Seminar 8 (Intermediate)

Accelerating Thermal System Simulation with AI

Track: Artificial Intelligence and the Built Environment

Room: Grand Ballroom 2

Sponsor: 1.13 Optimization

Chair: Rohit Sharad Dhumane, PhD, Associate, Trane Technologies, Davidson, NC

This session explores several ways in which AI and surrogate models enhance model-based design, optimization and control of thermal systems. The main objective is to highlight how surrogate modeling techniques, when applied to HVAC equipment, can greatly reduce the computational costs associated with complex physics-based models. This reduction in computational cost opens up new possibilities for design exploration and analysis that were previously unattainable. Additionally, the session offers valuable insights into the challenges and best practices of applying AI techniques in applications that typically lack extensive data.

1. Using Random-Forest Machine Learning to Model a Direct Expansion Heat Pump for Model Predictive Control

Zheng O'Neill, Ph.D., P.E., Fellow Member, Texas A&M University, College Station, TX

2. Using Metamodeling Techniques to Accelerate the Evaluation for Thermal Storage Components/Systems

Ransisi Huang, PhD, Associate¹ and **Jason D Woods, PhD, Associate²**, (1)National Renewable Energy Lab, DENVER, CO, United States, (2)National Renewable Energy Laboratory, WASHINGTON, DC

3. Harnessing the Power of Machine Learning for Duty Cycle Simulation of Transport Refrigeration Units

Rohit Sharad Dhumane, PhD, Associate, Trane Technologies, Davidson, NC

11:00 AM - 12:30 PM

Seminar 9 (Intermediate)

Achieve Resource Efficiency in Controlled Environment Agriculture

Track: Research Summit



Room: Grand Ballroom 7

Sponsor: 7.5 Smart Building Systems, 2.2 Plant and Animal Environment, MTG.CEA

Chair: Kevin Muldoon, Full Member, KCC Manufacturing, Louisville, KY

Controlled environment agriculture (CEA) grows crops year-round under controlled conditions including lighting, temperature, humidity, carbon dioxide, water and nutrients. CEA has the potential to contribute to improving community benefits and to addressing grand challenges such as climate change and food security. However, the energy-intensive nature and high carbon footprint make the CEA

industry difficult to be sustainable. This seminar presents different modeling techniques for predicting performance of complexed CEA facilities, operational controls and emerging technologies to improve the resource efficiency of CEA systems and reduce environmental impacts.

1. Modeling Thermal Loads in Indoor Cultivation Spaces

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

2. The Role and Impact of CHP, Thermal Storage, Battery Storage and Absorption Cooling Technologies in Controlled Environment Agriculture Energy Dispatch

Jacob Christian Seiler, The Pennsylvania State University, State College, PA

3. An Integrated Modeling Approach for Controlled Environment Agriculture

Liping Wang, PhD, S-B-a Member, University of Wyoming, LARAMIE, WY

4. Detailed Energy Modeling for Indoor Agriculture

Jeffrey H Kelley, Owner/Founder, Full Member, Kelley Energy Management LLC, BRENTWOOD, MO

11:00 AM - 12:30 PM

Seminar 10 (Intermediate)

Help has Arrived! Decarbonizing Heating Systems for Buildings

Track: Electrification: Possibilities and Pitfalls



Room: Grand Ballroom 3

Sponsor: 2.8 Building Environmental Impacts and Sustainability, Task Force for Building Decarbonization

Chair: Carol E Marriott, P. Eng., Full Member, Trane Technologies, Maple Grove, MN

Electrification of heating systems is a critical element in reducing the emissions impact of buildings on the road for decarbonization of the built environment. This seminar looks at the newest decarbonization guide for heat pumps and other strategies to achieve this goal. The session looks at strategies for shifting fossil fuel based heating and domestic hot water systems to electric systems. The seminar shows configurations for multiple building types, solutions for cold weather and addressing electrical limitations. Case studies will be included as well as decision pathways to help make electrification projects possible and practical.

1. The Process of Creating Electrification Design Guidance

Paul A Torcellini, P.E., Fellow Member, National Renewable Energy Laboratory, Golden, CO

3. Reality Hits: the Practical Aspects of Making Heating Systems Work

Stet Allen Sanborn, AIA, Full Member, Smithgroup, WASHINGTON, DC

11:00 AM - 12:30 PM

Seminar 11 (Advanced)

How Hard Can It Be? Simulating and Optimizing Compressors for Next Generation Systems and Refrigerants

Track: Research Summit



Room: Grand Ballroom 8

Sponsor: 8.1 Positive Displacement Compressors, 8.2 Centrifugal Machines

Chair: Craig R Bradshaw, Member ASHRAE, Full Member, Oklahoma State University, OKLAHOMA CITY, OK

This seminar aims to share the complexity and beauty of compression through the lens of the challenges associated with the development of compressors for next generation equipment. To this end, the presentations explore several modeling methods that are used for development and optimization of both positive displacement and centrifugal compressors as well as application and refrigerant selection. This includes mechanistic chamber models and CFD analysis used for compressor development and optimization. Additionally explored are advanced system-level models that are utilized for simulating compressor behavior installed in a piece of equipment.

1. New Characterization Methodology for Vapor-Injected Compressors and Its Comparison with Existing Black-Box Models

Amjid Khan, Student¹ and Craig R Bradshaw, Member ASHRAE, Full Member², (1)Oklahoma State University, Oklahoma City, OK, (2)Oklahoma State University, OKLAHOMA CITY, OK

2. Multi-Scale and Multi-Physics Modeling of Positive Displacement Compressors

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

3. CFD Model Validation for a Spool Compressor Using a Coupled Fluid and Solid Solver

Ameya Waikar¹, David Rowinski, PhD¹, Greg Kemp², Joe Orosz² and Craig R Bradshaw, Member ASHRAE, Full Member³, (1)Convergent Science, LLC, Madison, WI, (2)Torad Inc., Cumming, GA, (3)Oklahoma State University, OKLAHOMA CITY, OK

4. Study of Performance Changes of Centrifugal Compressor Working in Different Refrigerants

Yintao Wang, Full Member and Jin Yan, Member, Danfoss Turbocor, Tallahassee, FL

11:00 AM - 12:30 PM

Seminar 12 (Advanced)

How High Can You Get with High Temperature Heat Pumps?

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 9

Sponsor: 1.1 Thermodynamics and Psychrometrics

Chair: Raymond W Rite, Ph.D., Full Member, Trane Technologies, Tyler, TX

With the intense focus on all things electric, the use of heat pumps in applications that were once only in the realm of direct combustion is becoming more prevalent. However, what are the limitations on heat pump heating: Comfortable supply air temperatures? No problem. High supply water temperatures for radiant heating? Sure. Water temperatures necessary for industrial processes? Let's talk about that. This seminar provides information on where the limits are, what the issues are and where we are right now in state of the art heat pump heating. We will be getting high (temperature), so please indulge responsibly.

1. High-Temperature Heat Pumps, the Performance Constraints Based on the State-of-the-Art

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

2. High Temperature Heat Pumps for Steam Generation: Design and Operation Experiences

Stefan Elbel, Full Member, TU Berlin, Urbana, IL

3. High-Temperature Heat Pumps for Even Higher Temperature

Yunho Hwang, PhD, Fellow Member, University of Maryland/Department of Mechanical Eng, College Park, MD

4. Low Global Warming Refrigerant Options for High Temperature Heat Pump Applications

Michael Petersen, Associate, Trane Technologies, Bloomington, MN

11:00 AM - 12:30 PM

Forum 2 (Basic)

Integrating Thermal Storage and 40% Tax Credits into ASHRAE Standard 90.1

Track: Legislation, Standards, Codes, and Guidelines

Room: Grand Ballroom 1

Sponsor: 6.9 Thermal Storage, 7.3 Operation, Maintenance and Cost Management

Chair: Amy Van Asselt, Full Member, Lafayette College, EASTON, PA

The Inflation Reduction Act of 2022 provided a 40% tax credit for thermal energy storage systems. This fundamentally changes the economics of thermal storage. Where do ASHRAE members obtain details on annual energy cost savings, GHG emissions and equipment costs? How is thermal storage treated in ASHRAE Standard 90.1? How does 90.1 treat utility demand charges, peak periods, on-peak energy, off-peak energy, and utility emissions, which drive the economics?

Sunday, June 23, 1:30 PM - 3:00 PM

Panel 1 (Basic)

Liquid Cooling Data Center Deployments User Case: A Recipe for Success

Track: Fundamentals and Applications

Room: Grand Ballroom 3

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

Chair: John C Groenewold, PE, Full Member, Vantage Data Centers, Parker, CO

With the accelerating transition to liquid-cooled (LC) ITE, the paradigm is shifting for team engagement and project execution. This session discusses key differences in facility technical requirements for AC vs LC ITE and walk through an example engagement of a project team scoping, designing, constructing and deploying liquid-cooled ITE in a data center. Different liquid-cooling topologies, hybrid air- and LC deployments, managing IT-solutions changes during design and construction will be discussed. Understanding the questions to ask of ITE OEMs, LC solutions providers, and design engineers and how they interface throughout the project are key to success.

1. Liquid Cooling Data Center Deployments: A Recipe for Success

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

2. Liquid Cooling Data Center Deployments: ITE Vendor's Perspective

Dustin W Demetriou, PhD, Full Member, IBM, Hyde Park, NY

3. Liquid Cooling Data Center Deployments: Owner's Perspective

Nachiket Patwardhan, Member, Vantage Data Centers, Santa Clara, CA

4. Liquid Cooling Data Center Deployments: Solution Vendor's Perspective

Russell C Tipton, P.E., Life Member, Vertive, Westerville, Ohio., OH

1:30 PM - 3:00 PM

Conference Paper Session 6 (Basic)

Research on Building Technology and Monitoring

Track: Research Summit



Room: Grand Ballroom 10

Chair: Michael B Pate, Life Member

This session features papers cover recent research on building technology, instrumentation and monitoring.

1. Integrating IR, HDR, and Lidar Cameras into Building Controls (IN-24-C013)

Damon Woods, Assistant Professor, Associate, Felino Macatuno, Student and Natalie Ayala, Student, University of Idaho Integrated Design Lab, Boise, ID

2. Assessing Awareness and Willingness of College Students to Participate in Demand-Side Management Strategies: A Survey-Based Approach (IN-24-A005)

Patricia Guillante, Student¹, Jeonga Kang, Student² and Kristen Sara Cetin, PE, Full Member³, (1)Michigan State University, East Lansing, MI, (2)Michigan State University, East Lansing, MI, (3)Michigan State University, EAST LANSING, MI

4. Drone-Mounted Photoionization Detector Protocol for Improved Outdoor Dispersion Measurements (IN-24-A006)

Oluwatosin Olubunmi Onihale, Student and Jordan D. Clark, PhD, S-B-a Member, The Ohio State University, Lewis Center, OH

1:30 PM - 3:00 PM

Seminar 13 (Intermediate)

Better Data and Analytics Enable Better Decision Making on Building Operations and Decarbonization

Track: Artificial Intelligence and the Built Environment



Room: Grand Ballroom 1

Sponsor: MTG.OBB Occupant Behavior in Buildings, 7.3 Operation, Maintenance and Cost Management , TC 7.10

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

Research-grade datasets, compliant with the FAIR principles, from real buildings can address essential gaps that limit our present data analytics and machine learning capabilities. However, it is time-consuming and hard to find datasets that have adequate data coverage, good data quality and clear documentation. This seminar presents building performance datasets and various data tools used to curate, standardize and publish the datasets. Case studies of applying data analytics and machine learning to extract valuable information for informing improvements of building operations and decarbonization will be presented. Challenges and opportunities in curating and using FAIR datasets will also be discussed.

1. FAIR Datasets for Buildings Research

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

2. Vizbrick: Visual Brick Model Authoring Tool for Building Metadata Standardization

Piljae Im, Ph.D., Full Member, Oak Ridge National Laboratory, OAK RIDGE, TN

3. Metadata Ontologies for Data Discovery and Portable Analytics

Gabe Fierro, Dr., Associate, Colorado School of Mines, Golden, CO

4. Managing Public Disclosure and Building Performance Data for District Energy System Modeling

Nicholas L Long, PE, Full Member, NREL, LAKEWOOD, CO, United States

1:30 PM - 3:00 PM

Seminar 14 (Intermediate)

LIVESTREAM: Challenges of Defining an IEQ Metric(s) for Development of an IEQ Standard

Track: Legislation, Standards, Codes, and Guidelines



Room: Grand Ballroom 4

Sponsor: 2.1 Physiology and Human Environment, 2.1 Physiology and Human Environment , SCGP10, EHC

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

ASHRAE's Mid-Strategic plan second initiative area calls for the development of a standard addressing air quality, thermal environment, light, sound and vibration in an integrated way. Guideline 10 may be the start to the development of this IEQ Standard; however, what is missing to development and IEQ Standard is a metric to determine the success of meeting the standard. Ideally such a standard and

metric(s) would sustain and possibly improve the health of the building occupants so should this metric(s) be health-based. This seminar discusses the challenges of defining an IEQ metric(s).

1. The Challenges and Need to Develop an IEQ Metric for Development of an IEQ Standard

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

2. On the Quest for Rating Indoor Environmental Quality: The Rating Scheme Tail

Pawel Wargocki, Dr., Fellow Member, DTU Environ and resource Eng-Tech Univ of Denmark, Kongens Lyngby, Denmark

3. Bridging the Gap: Challenges in Linking Indoor Environmental Quality to Individual Health Metric

John McKeon, MD, Associate, iAIR Institute, Washington, DC

4. IH Approach to IEQ Metrics

Donald Weekes Jr, Full Member, Retired

1:30 PM - 3:00 PM

Seminar 15 (Intermediate)

Communication, Prioritization and Management Skills for Engineers

Track: Workforce Development



Room: Grand Ballroom 2

Sponsor: 1.7 Business, Management & General Legal Education

Chair: Danielle Passaglia, Mechanical Engineer, Full Member, SmithGroup, WASHINGTON, DC

Ever have trouble getting your point across especially to a non-technical audience, client, or stakeholder? Need help prioritizing your work and figuring out what can be delegated? Want to learn all that you need to know to be the best manager you can be? This seminar will set you up for career success with all the skills they don't teach you in college!

1. The Power of EQ: Bridging the Gap between Technical Brilliance and Human Connections

Karine Leblanc, National Sales Manager, Full Member, iAIRE, LLC, INDIANAPOLIS, IN, United States

2. Prioritization and Delegation: Preparing Yourself to Lead

Nancy W Kohout, Professional Engineer, Full Member, SmithGroup, Chicago, IL

3. Understand Your Leadership Style and Position Yourself for Success As a Manager

Madison W Schultz, PE, Full Member, ADG|Blatt, Oklahoma City, OK

1:30 PM - 3:00 PM

Seminar 16 (Advanced)

Energy Efficiency and Innovative Decarbonization Technologies for HVACD in Controlled Environments for Agriculture

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 7

Sponsor: 2.2 Plant and Animal Environment, 8.10 Mechanical and Desiccant Dehumidification Equipment, Heat Pipes and Components, MTG.CEA

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

Due to climate change, food production needs and decentralizing farming because of transportation fuel costs in both carbon and cash, CEA is growing in popularity and market needs are requiring that energy efficiency of HVACD systems be optimized for this application. This seminar will focus on how to apply different styles of equipment for HVACD, special considerations and potential pitfalls, and ultimately energy efficiency advantages of each climate control technology. This session looks at the advantages of integrating systems vs. unitary equipment and explore the use of alternate dehumidification strategies like Wraparound Heat Pipe, Liquid Desiccant and Total Enthalpy Wheels.

1. Energy Efficiency of Integrated HVAC Systems vs. Unitary As Applied to Cannabis Cultivation

Jim Megerson, PE, Member, Anvil Ag, Kansas City, KS

2. The Use of Wraparound Heat Pipes for Latent Enhancement Equipment for Energy Efficiency

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

3. Use of Total Enthalpy Wheel Energy Recovery in CEA

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

4. Use of Liquid Desiccants in CEA

Lavanya Jakka, MS (Mechanical Engg.), Associate, AIR GREEN, New Castle, DE

1:30 PM - 3:00 PM

Seminar 17 (Intermediate)

How Can Connected Communities Support Global Legislative Decarbonization and Electrification Targets Cost-Effectively and at Scale?

Track: Electrification: Possibilities and Pitfalls



Room: Grand Ballroom 8

Sponsor: 7.5 Smart Building Systems

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

Connected Communities (CCs) are key to decarbonizing and electrifying the built environment and mitigating climate change; they consist of grid-interactive buildings with flexible distributed energy resources (DERs) that collectively support reliability and resiliency when the power generation is fully decarbonized. The seminar will provide an overview of coordinated control architectures of the ten U.S. Department of Energy's CC Projects, show how a hard-to-reach segment of CCs can support compliance with Building Performance Standards and show how DERs installed at scale in new and existing all electric homes can help utilities decarbonize while maintaining grid reliability.

1. Coordinated Control Architectures to Support Community-Scale Decarbonization of Buildings and the Grid.

Paul Lazlo, Affiliate, Lawrence Berkeley National Laboratory, Berkeley, CA

2. How Do Connected Communities Support Compliance with Building Performance Standards (BPS) in Hard-to-Reach Segments?

Sivakumar Sankaranarayanan, Full Member, Electric Power Research Institute, Palo Alto, CA

3. How Can Distributed Energy Resources be Installed at Scale in New and Existing All Electric Homes to Help Utilities Decarbonize While Maintaining Grid Reliability

Andrew Poerschke, IBACOS, Pittsburgh, PA

1:30 PM - 3:00 PM

Seminar 18 (Intermediate)

We're Not Blowing Smoke: What You Need to Know About Wildfire Smoke

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 9

Sponsor: 2.3 Gaseous Air Contaminants and Gas Contaminant Removal Equipment, 2.4 Particulate Air Contaminants and Particulate Contaminant Removal Equipment

Chair: Caitlin D Naske, Full Member, Dynamic Air Quality Solutions, Princeton, NJ

In recent years, wildfire events have been increasing in frequency and intensity. These wildfires generate a wide range of contaminants, including particle matter and gases that greatly impact air quality. These contaminants impact the immediate areas but also travel great distances, especially the smallest particles. These small particles (PM2.5 and ultra-fine particles) are also the most detrimental to health. What's more, wildfire events happen quickly and often with little warning. This seminar series addresses the importance of not only understanding why wildfire smoke is dangerous, but how to protect building occupants and how to prepare a building in advance.

1. Is Your Merv-13 Filter Protecting You from Wildfire Smoke?

Sissi Liu, Associate, Metalmark Innovations, PBC.

2. The Components of Smoke and Guidance for Filtering It Out of the Air

David A Schaaf Jr, Full Member, Mann+Hummel, Mount Pleasant, SC

3. No Preparation or Planning = No Protection; How to Prepare for a Smoke Event

Michael W Gallagher, PE, fellow ASHRAE, Fellow Life Member, Western Allied Corporation, La Habra Heights, CA

4. Is Your Hospital Ready for the Next Wildfire?

Abdel Kader Darwich, PE, LEED AP, HFDP, Full Member, Guttmann and Blaevoet, Sacramento, CA

Sunday, June 23, 3:15 PM - 4:45 PM

Panel 2 (Basic)

Back to School: Improving School Building HVAC and IAQ Performance

Track: HVAC&R Systems and Equipment

Room: Grand Ballroom 3

Sponsor: 9.7 Educational Facilities, Government Affairs, Student Activities

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

The U.S. Department of Energy, Lawrence Berkeley National Laboratory and ASHRAE are piloting a joint effort to increase awareness of and submission for two programs: Renew America's Schools, which provides grant funding for building upgrades; and Efficient & Healthy Schools, which provides recognition for improving energy and IAQ performance. Twenty ASHRAE chapters are participating. Some assist with writing applications. Some provide pro bono energy audits. Some provide training. This moderated discussion explores what members of the Detroit and Miami Chapters are doing, the building improvements they're proposing, lessons learned and how to replicate these efforts in other chapters.

1. Using Building Analytics to Improve School Building HVAC and IAQ Performance

Alan H Deal, P.E., Full Member, Performance Engineering Group, Inc., Livonia, MI

2. Using ASHRAE Chapter Teamwork to Improve School Building HVAC and IAQ Performance

Haleh Moghaddasi, Ph.D., LEED GA, Assoc. AIA, Full Member, EXP, MAITLAND, FL, United States

3:15 PM - 4:45 PM

Seminar 19 (Intermediate)

LIVESTREAM: Farewell VRP: Paving the Way for Indoor Air in the Future of Ventilation and Air Quality

Track: Legislation, Standards, Codes, and Guidelines



Room: Grand Ballroom 4

Sponsor: SSPC62.1, SSPC170

Chair: Hoy R Bohanon Jr, PE, Life Member, Hoy Bohanon Engineering, PLLC, Lexington, NC

The IAQP in ASHRAE 62.1 has undergone significant enhancements, now incorporating specified design compounds and particulate matter with their established design limits. Additionally, there is a newfound emphasis on evaluating the impact of mixtures on human health. These improvements build upon the IAQP's longstanding requirements for mass balance analysis and extend to testing in finished spaces, complete with specific test method specifications and equipment accuracy standards. These advancements in IAQP within ASHRAE 62.1 not only enhance ventilation air quality standards but also hold the potential to serve as a model for achieving energy savings across the board.

1. The Harm Paradigm for IAQ

Benjamin Michael Jones, PhD, Full Member, University of Nottingham, Nottingham, United Kingdom

2. IAQP in 62.1: A Successful Mission

Marwa Zaatari, PhD, Full Member, D Zine Partners, Austin, TX

3. IAQ Procedure in 62.2: Embarking on the Journey

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

4. IAQP in 170 (Healthcare)

Michael P Sheerin, PE, Full Member, TLC Engineering for Architecture, Orlando, FL

Monday, June 24

Monday, June 24, 8:00 AM - 9:00 AM

CIDCO Keynote 1 (Intermediate)

Technology's Evolving Role in Advancing Decarbonization in Building Design, Construction and Operation

Room: Grand Ballroom 5 & 6

Chair: Kent Peterson, P2S Inc.

This keynote unravels a vital discourse on combatting climate change by propelling decarbonization within the spheres of building design, construction and operation. It introduces a paradigm shift from carbon-intensive methodologies to innovative digital instruments that emerge as dynamic agents of change. The talk crescendos into a persuasive call to action, advocating for the adoption of these technologies to cultivate a decarbonized built environment.

Technology's Evolving Role in Advancing Decarbonization in Building Design, Construction and Operation

Kent Peterson

8:00 AM - 9:30 AM

Panel 3 (Intermediate)

Implementation of Codes and Standard for Flammables (A2L, A3) for Supermarket Refrigeration System

Track: Legislation, Standards, Codes, and Guidelines

Room: Grand Ballroom 3

Sponsor: 10.7 Commercial Food and Beverage Refrigeration Equipment, 3.1 Refrigerants and Secondary Coolants , Refrigeration Technology Committee for Comfort, Process, and Cold Chain

Chair: Samuel Yana Motta, Oak Ridge National Laboratory, Oak Ridge, TN

Flammable refrigerants have been gaining attention in the supermarket refrigeration industry due to their lower global warming potential (GWP). Their flammability characteristics pose new challenges for field implementations and require careful interpretation of current safety standards and practical field consideration. This panel aims to have a deep dive discussion on field implementations of flammables (A2L, A3) in supermarket refrigeration.

1. Practical Considerations in System Engineering When Adopting Flammables Refrigerants

Tom D Wolgamot, Full Member, DC Engineering, Missoula, MT

2. Racks and Cases with Flammables

Bruce Hierlmeier, PE, Member, zero zone, North Prairie, WI

3. Refrigerant Considerations for Implementing Flammables for Supermarket

Doug Starasinic, Honeywell, Honeywell International, Morris Plains, NJ

4. Condensing Units with Flammable Refrigerants to Comply with UL60335-2-89

Roxanne M Scott, Full Member, Copeland, Sidney, OH

8:00 AM - 9:30 AM

Seminar 20 (Basic)

Building a Strong Foundation: Control and Pump Design Essentials for New Engineers

Track: Fundamentals and Applications



Room: Grand Ballroom 7

Sponsor: YEA

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

This session addresses the foundations for designing and specifying controls systems and pump systems. The goal is to give attendees a basic understanding and guidelines for how to specify items they don't specialize in. It ends with the common mistakes and misses we see in the industry today.

1. Flowing with Confidence: Unveiling the Essentials of Pump Design

Paul David Fernandez, Sales Engineer, Associate, Mechanical Solutions Indiana, Indianapolis, IN

2. Mastering HVAC Systems: Exploring the Fundamentals of Control System Design

Branislav Cvijetinovic, Full Member, AtkinRealis Inc., Vancouver, BC, Canada

3. Raising the Bar: Avoiding Common Pitfalls in Plans and Specifications for New Engineers

Madison W Schultz, PE, Full Member, ADG\Blatt, Oklahoma City, OK

8:00 AM - 9:30 AM

Seminar 21 (Intermediate)

LIVESTREAM: Emerging Air Purification Technologies

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 4

Sponsor: 2.9 Ultraviolet Air and Surface Treatment, 2.3 Gaseous Air Contaminants and Gas Contaminant Removal Equipment

Chair: Scott Sherwood, Full Member, Eco Care Corporation, NEW YORK, NY

New UVC and other air purification technologies are constantly evolving to address the changing requirements of the built environment. Research and development have now shifted to installation and operation of new systems and equipment, improvements to existing systems and equipment and the proper application and operation of systems and equipment. The pandemic highlighted the need to reduce energy and operating footprint. These technologies offer both.

1. The ABC's of Induction UV: Both Air and Surface Disinfection

Robert W McCullough, PhD, Full Member, BioPhotonic Systems, LLC, Sausalito, CA

2. DC Airports Incorporating Upper Air UV into Terminals

Ashley Shipley, EverGreen UV, Memphis, TN

3. Field Studies with Ionization during the Pandemic

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

5. Using UV Sensitive Aerosol to Verify in-Room UV Device Effectiveness

Phil Arnold, Associate, Safetraces, Pleasanton, CA

8:00 AM - 9:30 AM

Seminar 22 (Intermediate)

Excellent Tools for Professional Development

Track: Workforce Development



Room: Grand Ballroom 8

Sponsor: 1.5 Computer Applications, 1.4 Control Theory and Application , College of Fellows

Chair: Michael A Pouchak, PE, Fellow Member, Honeywell International, Plymouth, MN

Engineering is a dynamic and fast moving profession. There is a significant investment in math and science coursework, and additionally technology, manufacturing and markets are demanding new skills quickly. Professional development is an important skill to master for engineers in all phases of their career. This seminar discusses resources that will benefit engineers through formal academic training, informal training, continuing education training, professional engineering Licensure (P.E. / P.Eng.) and PDH credits, and Mentoring.

1. Career Ownership for New Engineers

Eman Sherif Mohamed, Full Member, Haleon, Cairo, Egypt

2. Tools, Interpersonal Relationships and Digitization

Michael A Pouchak, PE, Fellow Member, Honeywell International, Plymouth, MN

3. College of Fellows Mentoring Overview

Samir R Traboulsi, Ph.D., P.Eng., Fellow Life Member, Thermotrade/Ranec, Beirut, Lebanon

4. PE Licensure: An Investment in Your Future

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

8:00 AM - 9:30 AM

Seminar 23 (Intermediate)

Planning for a Transition: Decarbonization in Indiana

Track: Electrification: Possibilities and Pitfalls



Room: Grand Ballroom 9

Sponsor: 7.1 Integrated Building Design

Chair: Elyse M Malherek, Associate, Willdan, ANAHEIM, CA

Many challenges are present along the path to electrifying and decarbonizing the built environment. Hear from four local industry leaders share their knowledge on how to overcome financial barriers, improve policies and energy codes, model buildings and their interactions with the grid during the design process, and incorporate emerging technologies in rural and urban settings. Learn about effective and forward-thinking solutions needed to track and achieve decarbonization goals.

1. Energy Codes and Policy Improvements to Support Electrification

Daniel Overbey, Browning Day Mullins Dierdorf Architects, Indianapolis, IN

2. Thrive Indianapolis Sustainability and Resiliency Plan

Morgan Mickelson, City of Indianapolis, Indianapolis, IN

3. Modeling for Electrification and Decarbonization in Existing Buildings

David Jonathan Deal, HEAPY

4. Grid Interactive Buildings and Emerging Technologies

Ben Simon, Willdan, ANAHEIM, CA

8:00 AM - 9:30 AM
Seminar 24 (Advanced)

The Power of T⁴: Recent Research in Radiative Surfaces

Track: Research Summit



Room: Grand Ballroom 10

Sponsor: 6.5 Radiant Heating and Cooling, 7.4 Exergy Analysis for Sustainable Buildings (EXER)

Chair: Robert Bean, Fellow Member, Retired, Chestermere, AB, Canada

It's a bright day for radiant science as new materials and technologies have been developed for day time discharge of thermal energy from inside buildings back into outer space via radiation. Solar collectors and now emitters for a non-compressor-based method for cooling.

What's not to like? But that's not all! On the inside new sensing methods and technologies are changing our paradigms of radiant systems. This totally T⁴ program leaves engineers with beaming smiles while riding the latest wave in electromagnetic energy.

1. Measuring and Manipulating Radiant Heat to Leverage the Missing Half of Thermal Comfort with New Technology

Forrest Meggers, Ph.D., Associate, Princeton University School of Architecture, Princeton, NJ

2. Passive Sky Radiant Cooling Roofing Materials for Building Energy Efficiency

Ardeshir Mofstakhari, PhD, Student, Oklahoma State University, OKLAHOMA CITY, OK

3. Benefits from Using Advance Radiative Films on Standard Roofs and Shelter in Place Structures

Atila Novoselac, PhD, S-B-a Associate, University Of Texas, AUSTIN, TX

Monday, June 24, 9:45 AM - 10:45 AM
CIDCO Panel 1 (Intermediate)

Beating the MacLeamy Curve

Room: Grand Ballroom 1

Chair: Richard Walter Fenrich, PhD, xStar Research, Blacksburg, VA, Amanda E Bogner, PE, Full Member, Energy Studio Inc, Omaha, NE, Daniel Overbey, Browning Day, Indianapolis, IN and Kevin Hutton, Full Member, IU Health

The MacLeamy curve illustrates the increasing costs of design modifications during the design process and is often used to advocate for smarter approaches to building design. Building information modeling tools and integrated process delivery strategies are two complementary approaches for navigating design complexities while achieving cost-effective designs. BIM and IPD rely heavily on architectural and engineering design software to enable design exploration, analysis, optimization, and collaboration. This panel brings industry experts together to explore recent advances in software tools and workflows which address the challenge of minimizing late-stage design changes while continuing to meet building cost and performance requirements.

Beating the MacLeamy Curve

Richard Walter Fenrich, PhD, xStar Research, Blacksburg, VA

9:45 AM - 10:45 AM
CIDCO Seminar 1 (Advanced)

AI and Building Performance: An Overview and Practical Application



Room: Grand Ballroom 2

Chair: Justin S Shultz, PhD, Associate, Page, Washington, DC

This seminar explores integrating artificial intelligence (AI) into building energy modeling. The approach automates energy modeling tasks, aligning with ASHRAE Appendix G guidelines. The methodology demonstrates AI's potential in early-phase energy modeling, allowing untrained users to perform advanced tasks through simple prompts. For professionals, it automates manual tasks, saving time and reducing errors. Challenges like data quality and interpretability are discussed with mitigation strategies. The presentation also envisions future directions for ASHRAE, emphasizing AI's role in enhancing energy modeling for global efficiency and carbon reduction. The proposed workflow showcases AI's impact on energy efficiency analyses and simplifies complex modeling procedures.

1. An Overview of AI for Building Performance Analysts: Opportunities and Challenges

Justin S Shultz, PhD, BEMP, Associate, Page, Washington, DC

2. AI-Integrated Energy Modelling Frameworks: Applications and Future Direction

Mo S Elsayed, PhD, Page, Washington, DC

9:45 AM - 10:45 AM

Conference Paper Session 7 (Basic)

Guidelines and Legislation Impact on Energy Efficiency

Track: Research Summit

Room: Grand Ballroom 9

Chair: Mahroo Eftekhari, CEng, Loughborough University, Loughborough, United Kingdom

Conference papers in this session describe the impact of energy efficiency guidelines and legislation on buildings and HVAC&R equipment.

1. Measuring Impact: Evaluating Various Thermal Zoning Simplification Methods on Energy Efficiency Measures Analysis (IN-24-C015)

Jiarong Xie, OPMP, Associate¹, Xing Lu, Ph.D., Associate Member², Yan Chen, Ph.D., Full Member³ and Jian Zhang, Ph.D.³, (1)PNNL, RICHLAND, WA, United States, (2)Pacific Northwest National Laboratory, Richland, WA, (3)Pacific Northwest National Laboratory, Portland, OR

2. Energy Performance Evaluation of Ashrae Guideline 36 Control Sequences in a Commercial Large Office Building (IN-24-C016)

Xing Lu, Ph.D., Associate Member¹, Yan Chen, Ph.D., Full Member², Sen Huang, Associate³, Robert Lutes¹ and Dragana Vrabie⁴, (1)Pacific Northwest National Laboratory, Richland, WA, (2)Pacific Northwest National Laboratory, Portland, OR, (3)Oak Ridge National Laboratory, OAK RIDGE, TN, (4)Pacific Northwest National Laboratory, West Richland, WA

3. Inflation Reduction ACT 2022 - §179D Tax Deduction & §45L Tax Credit (IN-24-C017)

Ruben Abreu, PE, CEM, LEED Green Associate, Full Member, Walker Reid Strategies, Inc., BOCA RATON, FL

9:45 AM - 10:45 AM

Conference Paper Session 8 (Basic)

Advances in Clothes Dryer Technology

Track: Research Summit



Room: Grand Ballroom 10

Chair: Ed Vineyard, Strata-G

New approaches for managing moisture in dryers and cooling systems and are explored in this session.

1. Experimental Evaluation of a Compact Liquid-Desiccant-Based Clothes Dryer System (IN-24-C019)

Vivek Mano Mohan¹, Behnam Ahmadi¹, Kyle R Gluesenkamp, Ph.D., Full Member², Kashif Nawaz, PhD, Associate³ and Sajjad Bigham, Full Member¹, (1)North Carolina State University, Raleigh, NC, (2)Oak Ridge National Laboratory, OAK RIDGE, TN, (3)Oak Ridge National Lab, Oak Ridge, TN

2. An Experimental Study of a Sorption-Based Clothes Dryer Utilizing Ionic Liquid (IN-24-C018)

Behnam Ahmadi¹, Masoud Ahmadi¹, Kashif Nawaz, PhD, Associate², Kyle R Gluesenkamp, Ph.D., Full Member³ and Sajjad Bigham, Full Member¹, (1)North Carolina State University, Raleigh, NC, (2)Oak Ridge National Lab, Oak Ridge, TN, (3)Oak Ridge National Laboratory, OAK RIDGE, TN

9:45 AM - 10:45 AM

Seminar 25 (Basic)

LIVESTREAM: Building EQ: Portal Updates and How It Was Used on New ASHRAE HQ Building

Track: Building Life Cycle Assessment



Room: Grand Ballroom 4

Sponsor: MTG BEQ

Chair: Trent Hunt, Member, Mechanical Products NSW, Salt Lake City, UT

This seminar walks through the building EQ portal, covering inputs, upgrades (including carbon score, site source multipliers), outputs and reports. Then it looks how Building EQ was used on the new ASHRAE net-zero ready HQ building and improvements made including using analytics and the both the energy and carbon scores shared.

1. Building EQ Portal Overview Including Carbon Score and Site Source Multipliers

Stephen B Roth, PE, Full Member, Carmel Software Corp, SAN RAFAEL, CA

2. Building EQ and ASHRAE HQ - Lessons Learned

John Constantine, PE, Full Member, DAF, Merritt Island, FL

9:45 AM - 10:45 AM

Seminar 26 (Intermediate)

Modeling Battery Storage Applications

Track: Electrification: Possibilities and Pitfalls



Room: Grand Ballroom 8

Sponsor: 4.10 Indoor Environmental Modeling

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

As we electrify our world, battery systems become ever more important for storing energy on small and large scales. This seminar will look at a couple of building-centric challenges related to maintaining battery systems. The first challenge involves properly venting hydrogen gas from an electronics cabinet containing lead-acid batteries and is addressed by physical modeling. The second challenge involves effective and efficient cooling of storage container of Li-Ion batteries both under steady-state and transient conditions and is addressed with CFD modeling.

1. Evaluation of Hydrogen out-Gassing from Overcharged Batteries within an Electronics Cabinet

Duncan Phyfe, Associate, Alden, Holden, MA

2. Compact Cooling System Applications: Battery Energy Storage

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

9:45 AM - 10:45 AM

Forum 3 (Basic)

What Does Equity Mean in HVAC&R Industry?

Track: Workforce Development

Room: Grand Ballroom 7

Sponsor: ASHRAE Board DEI Subcommittee

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

This forum will discuss how ASHRAE can better "serve humanity" which is core to its mission statement. The discussion will include: What is "social equity" in HVAC&R sectors? What are the barriers for accessing the technologies of HVAC&R industry? What role can ASHRAE play in achieving equitable solutions for all? What are ASHRAE members' responsibilities? What collaborations are required to be inclusive to serve humanity? We expect a lively brainstorming discussion around these questions. Attendees can share their thoughts and that will inform ASHRAE actions to enable a workforce to "serve humanity."

9:45 AM - 10:45 AM

Workshop 4 (Intermediate)

Mechanical Design of a Space Station

Track: Fundamentals and Applications



Room: Grand Ballroom 3

Sponsor: TC9.13 Space

Chair: John Constantine, PE, Full Member, DAF, Merritt Island, FL

If you were hired as a consulting engineer to design a new space station, how would you go about that? This workshop would identify a few common steps during a building HVAC system design and apply them to off-planet vehicle applications.

1. Mechanical Design of a Space Station: Part 1

Evan Connell, PE, Full Member¹ and Arup Bhattacharya, Ph.D., Associate², (1)Optima Engineering, CHARLOTTE, NC, (2)Louisiana State University, BATON ROUGE, LA

Monday, June 24, 10:00 AM - 11:30 AM

Forum 4 (Basic)

Networking Forum for Researchers in the Built Environment

Track: Research Summit

Room: White River Ballroom G

Chair: Brian M Fronk, Full Member, The Pennsylvania State University, University Park, PA

Please join your colleagues working in research and development for a networking forum. All are welcome including students, faculty, engineers, scientists and other researchers conducting research to solve problems in the built environment in academia, at national

laboratories, non-profits, industry and related areas. The outcome of this session will be new contacts in the R&D field with the goal of building new collaborations.

Monday, June 24, 11:00 AM - 12:00 PM

CIDCO Panel 2 (Intermediate)

Improving Productivity: Tools, Techniques and Policies

Room: Grand Ballroom 1

Chair: Drew Champlin, ASHRAE

Representatives from the conference sponsors discuss tools, techniques and policies that are available now to help improve productivity in design, construction and operations.

Improving Productivity: Tools, Techniques and Policies

Drew Champlin¹, **Victor Mirasola**², **Amir Roth**³, **Matthew Duffy**⁴ and **Giuseppe Ardito**, Ph.D.⁵, (1)ASHRAE, (2)TRANE, (3)DOE, (4)IES, (5)AutoDesk

11:00 AM - 12:00 PM

CIDCO Seminar 2 (Intermediate)

Energy and Carbon Reduction Modelling & Analysis



Room: Grand Ballroom 2

Chair: John D Bynum, PhD, Associate, Arup Ireland

This session explores energy and carbon reduction through several different analysis methods including using digital twin technology to model a chilled water plant to optimize energy, data analysis of case studies to understand embodied and operational carbon in multifamily house comparing retrofits, passive design and adaptive reuse, and a look at available data tools for designers wondering how the greening grid will play into their net zero calculations and projections.

1. Energy Optimization of a Chilled Water Plant through Intelligent Agents, Application Case: Design, Simulation and Implementation

Gina Correa and **Jean Pierre Correa**, Eng., Universidad Nacional de Colombia, Floridablanca, Colombia

2. Investments in Low-Carbon Living Focused on Operational and Embodied Carbon

Jonghwa Na, Gensler, New York, NY

3. Cambium, Crrem, and Egrid, Oh, My!

Alexandra Lowrie Love, Affiliate, JLL, Charlotte, NC

11:00 AM - 12:00 PM

Conference Paper Session 9 (Basic)

Electrification Technology

Track: Research Summit



Room: Grand Ballroom 9

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

This session explores different aspects of electrification from hazard mitigation in battery facilities to the use of fuel cells in building applications

1. From Static to Dynamic: Revolutionizing Electrical Emission Factors with ARIMA Data-Driven Models (IN-24-C020)

Max St-Jacques, PEng, Associate, Carleton University, OTTAWA, ON, Canada

2. Application Evaluation of Smart Farm Module Using Carbon Dioxide from Hydrogen Fuel Cell System in Apartments (IN-24-C021)

Sangwoo Ha¹, **Jinhee Song**¹, **Jung-Soo Mun**¹ and **Kyeongjun Kim**², (1)Research Institute of Technology, Lotte E&C, Seoul, Korea, Republic of (South), (2)Institute of Technology, S-Fuelcell Co.,Ltd., Suwon, Korea, Republic of (South)

3. Investigation of Fire Hazard Mitigation, Control and Ventilation for Battery Electric Bus Fire in Enclosed Vehicular Facility (IN-24-C022)

Hasan Raza, Mechanical Engineer, Associate¹, **William Connell**, Senior Technical Principle², **Silas Li**, PE, Member², **José Del Solar**, PE² and **Andrew Louie**, Mechanical Engineer, Full Member³, (1)WSP USA, New York, NY, (2)WSP, New York, NY, (3)WSP, NEW YORK, NY

11:00 AM - 12:00 PM

Conference Paper Session 10 (Basic)

Dehumidification Technology

Track: Research Summit



Room: Grand Ballroom 10

Chair: Michael B Pate, Life Member

This session explores different technology and related performance for dehumidification.

2. Comparison of Different Desiccant Wheel Modeling Methods: A Review and Case Study (IN-24-C023)

Hang Guan, Student¹, Mingzhe Liu, Ph.D., Student², Zhiyao Yang, Ph.D., Associate² and Zheng O'Neill, Ph.D., P.E., Fellow Member¹,

(1)Texas A&M University, College Station, TX, (2)Texas A&M University, COLLEGE STATION, TX

3. Analyzing the Performance of a Vapor-Compression Refrigeration Cycle Coupled with a Heating and De-Humidification Desalination System (IN-24-C024)

Muhammad Elbassoussi, Dahiru Lawal, M.A. Antar and Syed M Zubair, Distinguished Professor, Full Member, King Fahd University of Petroleum & Minerals, Dhahran, Saudi Arabia

11:00 AM - 12:00 PM

Seminar 27 (Advanced)

Autonomous AI Control of Mission Critical Cooling at Large Pharmaceutical Production Site

Track: Artificial Intelligence and the Built Environment



Room: Grand Ballroom 8

Chair: Stephanie Ferguson, Phaidra, Seattle, WA

The theme of this session is a discussion on real-world application of autonomous Artificial Intelligence control on a large, complex mission critical cooling system (60k ton chilled water district loop). The purpose is to educate the attending audience on chill plant (1) operational data collection and storage best practices, (2) cybersecurity and safe operation assurance and (3) results of a multi-year AI controls integration. This session would be a co-presentation between our leadership and the plant operations leadership for the pharmaceutical manufacturer that owns and operates the large district cooling system the AI controls have been deployed at.

1. Autonomous AI Control of Mission Critical Cooling at Merck's Largest Manufacturing Site

Stephanie Ferguson¹, Dan Shirley, Data Analytics Engineer², Melanie Malone, Sr Specialist, Central Utilities I&C² and Ben Tacka¹,

(1)Phaidra, Seattle, WA, (2)Merck, West Point, PA

11:00 AM - 12:00 PM

Seminar 28 (Intermediate)

LIVESTREAM: Decarbonizing Our Built Environment: Transforming Existing Buildings with Sustainable HVAC Systems

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 4

Sponsor: 7.1 Integrated Building Design

Chair: Marianna Vallejo, PhD, Jacobs, Portland, United States Minor Outlying Islands

In colder climates, the task of decarbonizing existing buildings becomes more intricate, yet remains entirely feasible. Especially when the grid is already powered by sustainable energy sources, enhancing HVAC systems becomes imperative for achieving nearly zero carbon emissions. This seminar showcases two exemplary cases of existing buildings that have undergone complete decarbonization and are fully operational.

The first case features an office space situated within a repurposed industrial facility, which achieves net-zero emissions on an annual basis. The second case highlights the transformation of a century-old city hall, witnessing a remarkable 96% reduction in carbon emissions following extensive renovations.

1. Breathing New Life into Montreal City Hall: A Journey of Decarbonization through Cutting-Edge HVAC Innovations

Lianne Cockerton, P. Eng., Full Member, Martin Roy et Associes, Deux-Montagnes, QC, Canada

2. Phoenix Rising: Decarbonization Journey of Architectural Offices

Martin Roy, P.Eng, Leed Fellow, Full Member, Martin Roy et Associes Inc Consulting, Deux-Montagnes, QC, Canada

11:00 AM - 12:00 PM

Seminar 29 (Basic)

Infiltration: Challenges and Impact to Load Calculation

Track: Fundamentals and Applications



Room: Grand Ballroom 7

Sponsor: 4.1 Load Calculation Data and Procedures

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

Infiltration is a difficult parameter to quantify, but also a parameter with a significant impact on heating and cooling load calculations. This seminar addresses fundamental code requirements regarding infiltration, the multitude of factors that play a part in infiltration uncertainty and the impact of infiltration uncertainty on load calculation.

1. Distilling Infiltration Data Info into Load Inputs

Christopher K Wilkins, PE, Full Member, RFS Engineering, LACONIA, NH, United States

2. Sensitivity of Load Calculation to Infiltration

Daniel Saleem Howard, Student, Oak Ridge National Laboratory, OAK RIDGE, TN

11:00 AM - 12:00 PM

Forum 5 (Intermediate)

The Future of Coordination between Standards 62.1 and 170

Track: Legislation, Standards, Codes, and Guidelines

Room: Grand Ballroom 3

Sponsor: SSPC 62.1 and SSPC 170 both voted to co-sponsor this forum

Chair: Abdel Kader Darwich, PE, LEED AP, Full Member, Guttman and Blaevoet, Sacramento, CA

Healthcare facilities are complex buildings that have a mix of "healthcare spaces" and "non-healthcare spaces". Designers of a healthcare facility will find themselves applying two standards, ASHRAE Standard 62.1 and Standard 170, side by side. Since 2017, the two standards committees established official liaisons to help coordinate the standards which has culminated in the publication of a unified method to do 62.1-170 ventilation calculations and, for the first time, adoption 62.1 Natural Ventilation Procedure to Healthcare spaces. But what does the users of both standards like to see further coordinated in the future?

2:15 PM - 3:15 PM

CIDCO Seminar 3 (Intermediate)

Integration of Design, Construction and Operation to Enhance Building Safety Outcomes

Room: Grand Ballroom 1

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

The tragic consequences of the Grenfell Tower fire in London in June 2017 has triggered the most fundamental review and reform of building safety law in the UK since World War II. It has driven major changes to the building code to require much greater integration of design and construction, stretching through into occupation for high rise apartment buildings. This session outlines the legal framework and also detail how this approach can deliver better building performance more generally.

1. Integration of Design, Construction and Operation to Enhance Building Safety Outcomes

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

2. The Effect of Integrated Design on Building Operations and Energy Consumption

Mahroo Eftekhari, CEng, Loughborough University, Loughborough, United Kingdom

3. Delivering Improved Building Performance through Integrated Design, Construction and Operation

Fiona Cousins, Arup, New York, NY

2:15 PM - 3:15 PM

CIDCO Seminar 4 (Intermediate)

Real Time Monitoring and Predictive Analysis



Room: Grand Ballroom 2

Chair: John D Bynum, PhD, Associate, Arup Ireland

This session discusses CEVAC, Clemson University's Center for Energy Visualization and Analytics. The new technology and innovative predictive analysis that is driving significant successes in consumption reduction and fault detection is covered. This session also asks,

"how much data is too much data"? "Are we asking the right questions"? The speaker focuses on data analytics starting with "what happened and why".

1. How Big Data and AI Optimize Campus Energy

Snowil Lopes, Clemson University, CLEMSON, SC

2. Tackling Inefficiencies: The Power of Using Your Data

Hannah Thomazin, Affiliate, U.S. Engineering Company Construction, Kansas City, MO

2:15 PM - 3:45 PM

Panel 4 (Basic)

Go Green or Go Home: Alternative Fuels Implementation and Lessons Learned

Track: Electrification: Possibilities and Pitfalls

Room: Grand Ballroom 3

Sponsor: 6.10 Fuels and Combustion

Chair: Patrick Adams Villaume, Full Member, Patterson Kelley, EAST STROUDSBURG, PA

Along the path of decarbonization, there are many forks in the road to make decisions for your space. The panel incorporates gas solution providers, manufacturers and researchers to have a holistic discussion on the pathways to incorporating alternative fuels such as hydrogen and other bio fuels into building spaces as a road towards decarbonization. This discussion will include how to implement these options into facilities as well as lessons learned from locations with the technology installed.

1. Go Green or Go Home: Alternative Fuels Implementation and Lessons Learned I

Gerrit Zijlstra, Dr. ir.¹, Yan Zhao, Full Member², Mark Skierkiewicz, PE, Full Member³, Alan Chmiel⁴ and Rakesh Zala⁵, (1)Intergas / Rheem, Netherlands, (2)Gas Technology Institute, DAVIS, CA, (3)UL Solutions, Northbrook, IL, (4)R.W. Beckett, North Ridgeville, OH, (5)Cleaver Brooks, THOMASVILLE, GA

2:15 PM - 3:45 PM

Panel 5 (Intermediate)

LIVESTREAM: Specifying, Procuring and Meeting Embodied Carbon MEP Requirements

Track: Building Life Cycle Assessment

Room: Grand Ballroom 4

Chair: Josh Jacobs, LEED AP+ BD&C, WAP Sustainability, Seattle, WA

For decades, engineers and manufacturers have been focused on minimizing operational greenhouse gas impacts. They have been very successful in this endeavor and have us on the precipice of near zero operational buildings. This is something to celebrate, but what if it is only half the battle? As we strive for near zero in operational carbon in our buildings, we need to remember to understand and then start to minimize the embodied impacts that our product/material selections have. This panel explores what some building owners and operators are doing about that and how manufacturers are rising to the challenge.

1. Panelist 1

Kellie Jensen¹, Andrew J Rhodes, Full Member², Kavita Vallabhaneni³, Clayton J Terry⁴ and Shannon Sajdak⁵, (1)Meta, Bend, OR, (2)Amazon, Seattle, WA, (3)BAC, Jessup, MD, (4)Carrier Corporation, FORT LAUDERDALE, FL, (5)Trane, Seattle, WA

Monday, June 24, 3:30 PM - 5:00 PM

CIDCO Panel 3 (Intermediate)

ASHRAE HQ Project: Lessons Learned

Room: Grand Ballroom 1

Chair: Ginger Scoggins, PE, CEM, CxA, FASHRAE, Presidential Fellow Member, Engineered Designs Inc, CARY, NC, Stephanie Reiniche, ASHRAE, Peachtree Corners, GA, Stanton Stafford, PE, LEED Fellow, Member, Buro Happold, Atlanta, GA and Darryl Boyce, Carleton University, Kemptville, Canada

ASHRAE renovated a 66,700 sq. ft. building, originally built in 1978 in metro Atlanta to be the Society's new net-zero energy-efficient global headquarters. The building incorporated the Society's energy and indoor air quality standards, while being cost effective, restorative, livable and resilient. Features like water efficient plumbing and landscape, energy efficient HVAC and lighting systems, as well as the ability to harness on-site energy production and be net-zero-energy-efficient were outlined as project goals. In this panel, former building committee chair and 2023-24 ASHRAE President Ginger Scoggins will moderate a discussion among project contributors as they examine lessons learned.

ASHRAE HQ Project

Ginger Scoggins, PE, CEM, CxA, FASHRAE, LEED-AP PE, Presidential Fellow Member, Engineered Designs Inc, CARY, NC

3:30 PM - 5:00 PM

CIDCO Seminar 5 (Intermediate)

A Better Future Weather File for Energy Simulation



Room: Grand Ballroom 2

Chair: Elyse M Malherek, Associate, Willdan, ANAHEIM, CA

Predicting the future is a very difficult business indeed. Future weather files such as fTMY and XMY attempt to estimate future energy use via energy modeling, but through cooperative research with climatologists and energy modelers, five areas for improvement were identified, new future weather files were created, and the methodology published. The weather files were put to the test and used to evaluate a suite of buildings and the results of different conservation measures based on energy efficiency and resiliency will be discussed.

1. Future Weather Modeling Methodology Review

Richard Graves, FAIA¹ and **Amanda Farris²**, (1)Center for Sustainable Building Research, Minneapolis, MN, (2)University of Minnesota Climate Adaptation Partnership (MCAP)

2. Improved Future Weather Methodology for Energy Simulations

Alexander B Harris, CEM - Certified Energy Manager, Associate, HGA, MINNEAPOLIS, MN, United States

3. Modeling Savings and Resiliency with Future Weather Files

Elyse M Malherek, Associate, Willdan, ANAHEIM, CA

Tuesday, June 25

Tuesday, June 25, 8:00 AM - 9:00 AM

CIDCO Keynote 2 (Intermediate)

Data Driven Future for Integrated Design, Construction and Operations

Room: Grand Ballroom 5 & 6

Chair: **Rajnish B Setty, Full Member, Setty & Associates International, PLLC, Washington, DC**

This talk presents a vision for a Data-Driven Future in Design, Construction, and Operations. Digital twins, serving as digital replicas of buildings, combined with AI, promise predictive optimization across a building's lifecycle. This innovative approach enables anticipatory adjustments to improve energy efficiency and occupant comfort, marking a shift to proactive building management. Essential to realizing this vision are advancements in digital twins for predictive analytics, dynamic ontologies for knowledge integration, and AI algorithms for learning from data. Despite challenges, this paradigm offers unparalleled opportunities for sustainability, operational efficiency, and occupant satisfaction, steering the built environment towards autonomy and intelligence.

Data Driven Future for Integrated Design, Construction and Operations

Rajnish B Setty, Full Member, Setty & Associates International, PLLC

8:00 AM - 9:30 AM

Debate 3 (Intermediate)

Which Air Pollutant Should ASHRAE Prioritize in Setting Standards for Indoor Air and Environmental Quality?

Track: Legislation, Standards, Codes, and Guidelines

Room: Grand Ballroom 3

Sponsor: SGPC-10

Chair: **Carl Grimes, HHS CIEC, Full Member¹**, **Albert H Donnay, Toxicologist, Full Member²**, **Charlene W Bayer, PhD, Fellow Life Member³**, **Pawel Wargocki, Dr., Fellow Member⁴** and **Paul Francisco, Professor, Fellow ASHRAE¹**, (1)Hayward Healthy Home, Denver, CO(2)Donnay Detoxicology LLC, Hyattsville, MD(3)Hygieia Sciences LLC, MARIETTA, GA, United States(4)DTU Environ and resource Eng-Tech Univ of Denmark, Kongens Lyngby, Denmark

Four air pollution experts with over 120 years of combined experience debate which indoor air pollutant ASHRAE should prioritize in setting standards: particulate matter, nitrogen dioxide, carbon dioxide or carbon monoxide. The session will end with audience voting anonymously online for the expert they think won the debate and separately, for whichever pollutant--or pollutants, up to 4--they think ASHRAE standards should prioritize.

Which Air Pollutant Should Ashrae Prioritize in Setting Standards for Indoor Air and Environmental Quality:Particulate Matter 2.5, Nitrogen Dioxide, Carbon Dioxide, or Carbon Monoxide?

Albert H Donnay, Toxicologist, Full Member, Donnay Detoxicology LLC, Hyattsville, MD

8:00 AM - 9:30 AM

Conference Paper Session 11 (Basic)

AI for Simulation, Commissioning, and Forecasting

Track: Research Summit



Room: Grand Ballroom 10

Chair: Paul A Torcellini, P.E., Fellow Member, NREL, LAKEWOOD, CO, United States

Four conference papers are presented exploring different aspects of using AI for building simulation, commissioning, and load forecasting.

1. Miscellaneous Electric Loads Prediction By Deep Learning Implementation: An Educational Case Study (IN-24-C025)

Shayan Mirzabeigi, Student¹ and Bing Dong, Ph.D., S-B-a Member², (1)Syracuse University, SYRACUSE, NY, (2)Syracuse University, Syracuse, NY

2. Event-Based Energy Impact Tracking and Forecasting with Limited Measured Variables for Rooftop Units (IN-24-C026)

Wei Liang, P.E., Associate¹ and Michael R Brambley, PhD, Fellow Life Member², (1)Carnegie Mellon University, PITTSBURGH, PA, (2)Pacific Northwest National Laboratory, Richland, WA

3. Generative Commissioning: AI & Digital Practice in the Building Commissioning Process (IN-24-C027)

Theophilus Aluko, P.E., CEM, BCxP, Affiliate¹ and Elijah Adeoye², (1)OLA Consulting Engineers, HAWTHORNE, NY, (2)Delta Dental of Washington, WA

4. Eplus-LLM: A Novel Automated Building Simulation Platform Using Natural Language (IN-24-C028)

Gang Jiang¹, Liang Zhang, Assistant Professor, Associate² and Jianli Chen, S-B-a Member¹, (1)University of Utah, Salt Lake City, UT, (2)The University of Arizona, Tucson, AZ

8:00 AM - 9:30 AM

Seminar 30 (Intermediate)

Current Topics in Humidity Control

Track: Fundamentals and Applications



Room: Grand Ballroom 7

Sponsor: 1.4 Control Theory and Application

Chair: James J Coogan, PE, Life Member, Siemens Smart Infrastructure, Chicago, IL

It sounds elementary, but, as a Society, we are still trying to get a handle on humidity control. Psychrometrically, where and when do we need it? Mechanically, how do we accomplish it? Algorithmically, how do we regulate it?

This session brings new thoughts on controlling humidification, and dehumidification and presents the thinking behind new dehumidification requirements in Standard 62.1.

1. Humidifier Control Based on Dewpoint Rather Than RH

Christopher A Miller, PE, CEM, CxA, Associate, P2S inc, Long Beach, CA

2. Indoor Dewpoint Limits in Standard 62.1

Elizabeth Christine Balke, PE, Associate, Tesla, Oakland, CA

3. Lessons Learned from Applying High-Performance Control Sequences in a Humid Midwest Climate

JoeDon Breda, Managing Research Engineer, Associate, TRC, Grove City, OH

8:00 AM - 9:30 AM

Seminar 31 (Basic)

DOE Student Competition for Jump into STEM Challenge: Three Winning Projects for Thermal Storage

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 8

Sponsor: 6.9 Thermal Storage

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

The US Department of Energy has sponsored a student competition since 2018, the Jump into STEM Challenge. This year, the topics were 1) thermal storage, 2) low-cost housing and 3) decarbonization. 92 schools participated and three were selected in each category. The winners receive a 10-week internship at a national lab. This year's winners in the thermal storage category were 1) Embry Riddle

Aeronautical University, 2) Purdue University, and 3) Worcester Polytechnic Institute. We invited the student teams to present at ASHRAE and encourage other colleges and universities to participate in the coming years.

1. Kiln Thermal Energy Storage

Bruce B Lindsay, PE, Life Member¹ and **Rebekah Shields, Student Member²**, (1)Trane Technologies, Melbourne, FL, (2)Worcester Polytechnic Institute, Worcester, MA

2. Reducing Barriers to Achieve an Energy Efficient Lifestyle for Low Income Families in the US

Andreas Josef Hoess, Graduate Research Assistant, Student, Purdue University, W LAFAYETTE, IN

3. Keppi' It Cool (or Hot)

Jared Caleb Williams, Student, Embry Riddle Aeronautical University, Daytona Beach, FL

8:00 AM - 9:30 AM

Seminar 32 (Intermediate)

Leveraging Airflow/IEQ Metrics in CFD for Building Design and Operation

Track: Building Life Cycle Assessment



Room: Grand Ballroom 9

Sponsor: 4.10 Indoor Environmental Modeling, 4.3 Ventilation Requirements and Infiltration , 4.3; 4.7; 9.9

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

Computer models of indoor environments can be valuable tools for optimization during the building design stages and for diagnosis or change-management during operation. While the physical quantities (such as air speeds and temperature values) predicted by these models provide indicators for the performance of the designed space, utilizing appropriate metrics can transform these physical quantities into values that speak directly to the end-users' requirements. This seminar presents examples of how airflow and indoor environment quality (IEQ) metrics are defined and applied to computational fluid dynamics (CFD) modelling of indoor environments.

1. Rationalizing Airflow and Energy-Flow Metrics for Data Center Cooling

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

2. Understanding Data Center Simulation Results Using Metrics

Matthew Laurence Kaufeler, MEng, Cadence Design Systems, Wincanton, United Kingdom

3. Evaluating the Impacts of Using a Personalized Comfort System on the Ventilation Effectiveness and Thermal Comfort

Mohammad Heidarinejad, Ph.D., P.E., Full Member, Illinois institute of Technology, CHICAGO, IL

4. Comparing Different Thermal Comfort Metrics Using CFD

Michael J Carl, P.Eng, Full Member, RWDI, Toronto, ON, Canada

8:00 AM - 9:30 AM

Seminar 33 (Intermediate)

LIVESTREAM: Mitigating Electrification Pitfalls with Thermally Driven Heat Pumps

Track: Electrification: Possibilities and Pitfalls



Room: Grand Ballroom 4

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

Electrification poses significant peak load challenges to the grid. This seminar covers information on how absorption heat pumps or other heat operated system used for cooling and heating can assist improve overall efficiency, promote decarbonization and reduce peak electric loads, and on how carbon emissions evaluations are impacted by these technologies.

1. Unlocking the Potential: Absorption Heat Pumps in Decarbonized Energy Systems

Gunther Gottfried Berthold, Full Member, Beckett Thermal Solutions, Formigine, Italy

2. Thermally Driven Heat Pumps for District Cooling and Heating

Amit Vatsa, Associate, Broad USA Inc

3. High Efficiency Chiller-Heaters

Rajesh Sinha, Director-Americas, Full Member, Thermax, Monroe Township

4. Understanding Marginal Carbon Factors and Why They Matter

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

Tuesday, June 25, 9:45 AM - 10:45 AM

CIDCO Panel 4 (Intermediate)

Generative AI Impact on Design and Construction

Room: Grand Ballroom 1

Chair: Krishnan Gowri, PhD, Fellow Member, Intertek Inc., Bothell, WA, Bilal Sher, Building Diagnostic Robotics, New York, NY, Ben Bartling, Slipstream, Madison, WI and Nathaniel Louis Jones, PhD, Arup, Lexington, MA

Generative AI applications have potential impact on all aspects of engineering consulting, design, operation, maintenance and general productivity improvements. This panel discussion will feature three industry experts highlighting the potential of using generative AI technologies for building diagnostics, HVAC system operation and maintenance and future directions for technology adoption.

1. Can We Replace an Engineer with a Large Language Model?

Nathaniel Louis Jones, PhD, Arup, Lexington, MA

2. Team Lighthouse: BE.AMentor

Jongki Lee, Student, Illinois institute of technology, Chicago, IL

3. Using the LLM to Troubleshoot Building Automation

Ben Bartling, Slipstream, Madison, WI

9:45 AM - 10:45 AM

CIDCO Seminar 6 (Intermediate)

Digital Twin Methodologies and Case Studies



Room: Grand Ballroom 2

Chair: Susan Collins, COO, Whole Building Systems, Mt Pleasant, SC

This session explores real life case studies about setting up and using Digital Twin technology to improve the predictive analysis and performance of operating the built environment.

1. From Deployment to Utility: Harnessing Your Digital Twin

David Solano, Georgia Institute of Technology, Atlanta, GA

2. A Digital Twin Case Study: How to Structure Your Data to Get Started

Rajnish B Setty, Full Member, Setty, Atlanta, GA

3. A Digital Twin Approach for District Energy Systems

Jung-Ho Lew, Ph.D., EMP, Full Member, Georgia Institute of Technology, Atlanta, GA

9:45 AM - 10:45 AM

Conference Paper Session 12 (Basic)

Case Studies in Building Retrofit and Energy Storage

Track: Research Summit



Room: Grand Ballroom 9

Chair: Amr Suliman, PhD, Full Member, University of Oxford, Loughborough, United Kingdom

This session describes case studies and new technology that advance decarbonization goals.

1. Tunable Thermal Energy Storage (TES) to Enable Decarbonization of Space Conditioning in Commercial Buildings (IN-24-C031)

Malcolm (James) Grieve, Full Member¹, Micah Sweeney, Associate², Alexander Dyllal¹ and Molly Over¹, (1)MicroEra Power, Rochester, NY, (2)EPRI, Knoxville, TN

2. Building Envelope Retrofit's Value to the Grid in New York State (IN-24-C030)

Xinxin Hu, Associate¹, Brett Webster² and Maggie Huang², (1)Rocky Mountain Institute, BOULDER, CO, (2)Rocky Mountain Institute, Boulder, CO

9:45 AM - 10:45 AM

Conference Paper Session 13 (Basic)

Application of Refrigerants

Track: Research Summit



Room: Grand Ballroom 10

Chair: Ed Vineyard, Strata-G

This session explores recent developments in refrigerant flammability, climate impact, and application in sustainable cooling.

1. New Developments on Investigating the Ignition Propensity of Mildly-Flammable Refrigerants (IN-24-C032)

Daniel Jaimes, PE, Associate¹ and Amir Jokar, PE, Full Member², (1)Exponent, Los Angeles, CA, (2)Exponent, Inc., Irvine, CA

2. A Practical Guide to Refrigerant Gwps and Their Impacts (IN-24-C033)

Stephen Kujak, Full Member¹, Michael Petersen, Associate² and Helen A Walter-Terrinoni, Full Member³, (1)Trane Technologies, Brownsville, MN, (2)Trane Technologies, Bloomington, MN, (3)AHRI, Arlington, VA

3. Direct-to-Chip Pumped Two-Phase and Single-Phase Immersion Hybrid Cooling System for Ultra-Efficient and Sustainable HPC Cooling (IN-24-C034)

Ali Heydari¹, Yaman Manaserh, Full Member², Pardeep Shahi¹, Mohammad Tradat¹, Bahareh Eslami¹, Vahideh Radmard¹, Uschas Chowdhury¹, Harold Miyamura¹ and Jeremy Rodriguez¹, (1)Nvidia, (2)Nvidia, Santa Clara, CA

9:45 AM - 10:45 AM

Seminar 34 (Basic)

Comparing Heat Pump Technologies: Updates to CSA and AHRI Standards

Track: Legislation, Standards, Codes, and Guidelines



Room: Grand Ballroom 3

Sponsor: 6.8 Geothermal Heat Pump and Energy Recovery Applications

Chair: Steven W Carlson, PE, Full Member, XRG Analytics, LLC., Milwaukee, WI

Representations of performance, part-load, and parasitics are updated in the new AHRI 600 and CSA standards covering water/brine-source heat pumps to align with seasonal performance values used in equipment comparisons and incentive programs. Ground-source heat pump application scopes are expanded to include district, geopiles and wastewater systems.

1. 2023 Revisions to ANSI/CSA C448 Design and Installation of Ground Source Heat Pump Systems for Commercial and Residential Buildings

Lisa M. Meline, P. E., Full Member, Meline Engineering Corporation, Sacramento, CA

2. Overview of the New AHRI 600 Performance Rating or Water/Brine to Air Heat Pump Equipment

Robert R Brown, Full Member, WaterFurnace, Markle, IN

9:45 AM - 10:45 AM

Seminar 35 (Intermediate)

Low-Cost Indoor Air Quality Sensors: Opportunities and Potential Hazards

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 7

Sponsor: 4.3 Ventilation Requirements and Infiltration, SSPC 62.1

Chair: Jordan D. Clark, PhD, S-B-a Member, The Ohio State University, Lewis Center, OH

Dozens of low-cost indoor air quality sensors have come on the market in the past decade. Applications spanning from continuous ventilation control to consumer education and scientific research have been suggested as potential frontiers enabled by these sensors. This seminar provides evidence of performance of these sensors in diverse applications and focus on dispelling myths about what these sensors can and cannot do.

1. ASHRAE Standards 62.1 and 62.2 and Low-Cost IAQ Sensors

Jordan D. Clark, PhD, S-B-a Member, Ohio State University, Columbus, OH

2. What Is in the Air in a Modern US Residence, and How Should We be Measuring It?

William W Delp, PhD, Full Member, Lawrence Berkeley National Laboratory, Berkeley, CA

3. Intelligent Use of Consumer Grade IAQ Sensors

Lawrence J Schoen, PE, FASHRAE, Fellow Life Member, Schoen Engineering Inc, COLUMBIA, MD

9:45 AM - 10:45 AM

Seminar 36 (Intermediate)

LIVESTREAM: The Future of Heating: Adaptive Compressors and Smart Capacity Modulation

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 4

Sponsor: 8.1 Positive Displacement Compressors, 8.2 Centrifugal Machines

Chair: Riley B Barta, PhD, Associate, Purdue University, W LAFAYETTE, IN

As the need for the efficient electrification of heating grows, the ability of heat pumps to cover a range of capacities over the course of the year, and to do so efficiently, is more apparent than ever. This seminar focuses on part-load operation of compressors in heating operation. Motivation and context for this topic will be provided with an overview of heat pump compressor design, followed by experimental results displaying the need for partial load behavior in heat pumps. Finally, a range of options and technologies for capacity modulation of heat pumps will be discussed.

1. What Makes a Heat Pump Compressor?

Craig R Bradshaw, Member ASHRAE, Full Member, Oklahoma State University, OKLAHOMA CITY, OK

2. Compressor Modulation for High-Performance Heat Pumps

Abd Alrhman Bani Issa, Eng, Student, Purdue University, W LAFAYETTE, IN

3. Modulation Options Pros and Cons

Alexander Schmig, Full Member¹ and Matthew Cambio, Principal Engineer, Full Member², (1)Trane Technologies, La Crosse, WI, (2)Trane Technologies, LA CROSSE, WI

Tuesday, June 25, 11:00 AM - 12:00 PM

CIDCO Panel 5 (Intermediate)

President's Roundtable on Workforce Development

Room: Grand Ballroom 2

Chair: Dennis Knight, P.E., Fellow ASHRAE, Whole Building Systems, LLC, Mt. Pleasant, SC, Darryl Boyce, Carleton University, Kemptville, Canada, Luke C H Leung, PE, Fellow Member, Skidmore Owings & Merrill, CHICAGO, IL, Martin Dieryckx, Fellow Member, Daikin Europe N.V., Torhout, Belgium and Jim Dahlin, Pipefitters Local Union No. 533

Join newly appointed ASHRAE president Dennis Knight and a panel of industry executives as they discuss the very real problem of Workforce Development for HVAC&R. Meeting the challenge of building and renovating high performance buildings that are carbon neutral and energy efficient will require skilled engineers, designers, contractors and facility managers. How will HVAC&R compete with other tech savvy industries to attract new workers and engage and upskill the existing workforce to face the world's most significant challenge – climate change?

President's Roundtable on Workforce Development

Dennis Knight, P.E., BEMP, Fellow ASHRAE, Whole Building Systems, LLC, Mt. Pleasant, SC

11:00 AM - 12:00 PM

CIDCO Seminar 7 (Intermediate)

BIM Standards and Guidelines for Integrated Building Design and Construction



Room: Grand Ballroom 1

Chair: Stephen B Roth, PE, Full Member, Carmel Software Corp, SAN RAFAEL, CA

Currently, there are many Building Information Modeling (BIM) standards and guidelines available in the marketplace. This seminar focuses on explaining 2 specific BIM standards including ASHRAE SPC-224 (an ANSI standard) and National Institute of Building Sciences' NBIMS 4.0. In addition, it focuses on how these standards are used in practice by owners, engineers, and architects. Speakers discuss the similarities and differences between them and how they could work together to provide a comprehensive set of BIM standards.

2. Overview of ASHRAE SPC-224: Standard for the Application of Building Information Modeling

Stephen B Roth, PE, Full Member, Carmel Software Corp, SAN RAFAEL, CA

3. Overview of the Next Generation BIM Standard at NIBS – National BIM Standard 4.0

Carrie Sturts Dossick, P.E., University of Washington, Seattle, WA

1. How Building Owners, Architects, and Engineers Can Use These Standards in the BIM Workflows

Kimberly Pierson, PE, CEM, GBE, PMP, LC, LEED GA, BEAP, Full Member, Moseley Architects, Raleigh, NC

11:00 AM - 12:30 PM

Conference Paper Session 14 (Basic)

VRF and Smart Thermostat Performance

Track: Research Summit



Room: Grand Ballroom 9

Chair: Mahroo Eftekhari, CEng, Loughborough University, Loughborough, United Kingdom

Papers in this session evaluate different aspects of VRF systems and the application of smart thermostats for fault detection and diagnosis.

1. Cooling Energy Consumption and Efficiency of VRF Systems Based on a Large-Scale Dataset (IN-24-C035)

Mingyang Qian, Dr., BEMP, Da Yan, Ph.D., Full Member and YI WU, Student Member, Tsinghua University, Beijing, China

2. Investigation on VRF System and Water Chiller System Operation Performance in Commercial Buildings Based on Large-Scale Dataset (IN-24-C036)

YI WU, Student Member¹, Mingyang Qian, Dr., BEMP¹, Hua Liu² and Da Yan, Ph.D., Full Member¹, (1)Tsinghua University, Nanjing, China, (2)State Key Laboratory of Air-conditioning Equipment and System Energy Conservation, Zhuhai, China

3. A Co-Simulation Based Study of Smart Thermostats' Potential for Fault Detection and Diagnosis (IN-24-C037)

Kevwe Andrew Ejenakevwe, Student¹ and Li Song, PhD, S-B-a Member², (1)University of Oklahoma, Norman, OK, (2)University of Oklahoma, NORMAN, OK

4. Energy Analysis of VRF System Configurations for Space Conditioning and Hot Water Production: A Simulation-Based Case Study (IN-24-C038)

Xing Lu, Ph.D., Associate Member¹, Junke Wang, Associate¹, Edward P Louie¹ and Veronica A Adetola, Full Member², (1)Pacific Northwest National Laboratory, Richland, WA, (2)Pacific Northwest National Lab, RICHLAND, WA

11:00 AM - 12:30 PM

Conference Paper Session 15 (Basic)

Fundamentals and Application of IAQ

Track: Research Summit



Room: Grand Ballroom 10

Chair: Som S Shrestha, Full Member, Oak Ridge National Laboratory, OAK RIDGE, TN

Papers in this session describe the impacts and methods of controlling IAQ.

1. Review on Multifunctional Air Purification System: Technology Combinations and Applications (IN-24-C039)

Jing Wu, Student¹ and Lexuan Zhong, PhD, S-B-a Member², (1)University of Alberta, (2)University of Alberta, Edmonton, Canada

2. Impact of Indoor Temperature and Humidity on the Microbiome Structure in Modern Japanese Residences (IN-24-C040)

Makiko Nakajima, Associate¹, Tomohide Akiyama², Jianjian Hou³, Daisuke Ogura, Full Member², Fumito Maruyama³, So Fujiyoshi³, Jun Noda⁴ and Ayako Fujieda⁵, (1)Hiroshima Institute of Technology, Hiroshima, Japan, (2)Kyoto University, Kyoto, Japan, (3)Hiroshima University, Hiroshima, Japan, (4)Rakuno Gakuen University, Hokkaido, Japan, (5)Kyoto Seika University, Kyoto, Japan

4. The Role of Heat Transfer in Smoke Control of Long Atria (IN-24-001)

Jonathan L. Hodges, Jensen Hughes, Blacksburg, VA

11:00 AM - 12:30 PM

Seminar 37 (Intermediate)

Particle and Contaminant Tracking for Health and Safety

Track: Research Summit



Room: Grand Ballroom 3

Sponsor: 4.10 Indoor Environmental Modeling, 2.3 Gaseous Air Contaminants and Gas Contaminant Removal Equipment, TC 2.3, TC 2.4, EHC

Chair: James W VanGilder, PE, Full Member, Lawrence Berkeley National Lab, BERKELEY, CA

This seminar shares the latest research findings in indoor environmental modeling, with a particular focus on particle and contaminant tracking for health and safety.

1. Pushing Boundaries: CFD and Particle Tracking for High Performance Labs

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

2. CFD Modeling and Empirical Measurements in Real-World Lab Space

Duncan Phyfe, Associate, Alden, Holden, MA

3. Quantifying Spatiotemporal Variability in Occupant Exposure to an Indoor Airborne Contaminant with an Uncertain Source Location

Wangda Zuo, PhD., S-B-a Member, Penn State University, MIDDLETOWN, PA

4. Indoor Air Pollution Modeling Based on the Satellite Derived Air Quality Data and Building Physics

Yang-Seon Kim, Wichita State University, Wichita, KS

5. Use of AI and Machine Learning to Optimize Airflows

Alexander Jerome Willman, PE, Full Member, AJWillman International LLC, CARLSBAD, CA, CA

11:00 AM - 12:30 PM

Seminar 38 (Basic)

Profiles in HVAC Engineering

Track: Workforce Development



Room: Grand Ballroom 7

Sponsor: 1.4 Control Theory and Application, 1.5 Computer Applications, College of Fellows

Chair: Michael A Pouchak, PE, Fellow Member, Honeywell International, Plymouth, MN

Careers in HVAC offer many opportunities for professional growth and fulfillment. The U.S. Bureau of Labor Statistics projects that Architecture and Engineering Occupations will experience above-average growth compared to all occupations between 2022 to 2032. This seminar explores the diverse career trajectories within our industry and the opportunities and challenges they entail. Participants can expect insightful discussions on career profiles within key sectors such as Consulting Engineering, Manufacturing, Academia, Research, or Government.

1. Architectural Engineering Education As Pathway to a Charmed Career

Filza H Walters, Fellow S-B-a Member, Texas A&M University, COLLEGE STATION, TX

2. Engineering Practice

Thomas M Lawrence, PhD, LEED-AP P.E. Ph.D., Fellow Life S-B-a Member, University of Georgia, ATHENS, GA

3. Product Development and System Architecture

Michael A Pouchak, PE, Fellow Member, Honeywell International, Plymouth, MN

4. Staff Scientist

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

5. Consulting Engineer

Frank Shadpour, Mechanical Engineer, ASHRAE Fellow, HFDP, Fellow Life Member, SC Engineers, Inc., San Diego, CA

11:00 AM - 12:30 PM

Seminar 39 (Intermediate)

Simplifying the Electrification of Hydronic Systems

Track: Electrification: Possibilities and Pitfalls



Room: Grand Ballroom 8

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

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

With the push for decarbonization, designers are often faced with challenges in retrofit or new designs using electrified heating systems. Equipment may be new and certain facets of design, sizing and operating need to be considered for a successful electrified design. For existing systems, the distribution system must be considered to determine applicable equipment. Depending on the local generation assets providing electric power, overall system efficiency must be considered to determine how much electrification is needed to decarbonize today, and what the end result will look like as renewable resources are added to grids.

1. Harmonization of Hydronic Fluid Temperatures: A Strategy for Simplification in Electrification

Robert Bean, Fellow Member, Retired, Chestermere, AB, Canada

2. Hybridization As a Phasedown Approach to Decarbonization

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

3. Watts the Challenge?

Sarah Hilden, Full Member, Trane, Onalaska, WI

11:00 AM - 12:30 PM

Seminar 40 (Intermediate)

LIVESTREAM: The Link Between Dehumidification And Decarbonization

Track: Fundamentals and Applications



Room: Grand Ballroom 4

Sponsor: 1.1 Thermodynamics and Psychrometrics

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

Moisture management in buildings and industrial processes consumes an extensive amount of energy. The conventional approach of condensing the moisture through cooling to dew point temperature and subsequent heating to meet the desired dry bulb conditions makes the process highly inefficient and CO2 emissions intense. In order to meet our decarbonization goals a disruptive approach to moisture management in buildings is required. This session presents different dehumidification technologies based on novel materials and system architectures. The first two presentations focus on material characterization and innovation while the latter presentations demonstrate a novel highly efficient membrane based dehumidification technology.

1. What Makes a Hygroscopic Material Suitable Adsorbent? Thermodynamic Characteristics Impacting System Level Performance

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

3. Molecular Membrane Dehumidifier: Part 1

Charles H Culp III, Dr, Fellow Life S-B-a Member, Texas A&M University, COLLEGE STATION, TX

4. Molecular Membrane Dehumidifier: Part 2

David E Claridge, Fellow Life Member, Texas A&M University, COLLEGE STATION, TX

Tuesday, June 25, 1:30 PM - 3:00 PM

CIDCO Low Show 1 (Basic)

Technology Exchange on Approaches for Integrated Design, Construction, & Operations

Room: Grand Ballroom 1

Chair: Weili Xu, Ph.D., Associate, PNNL, Richland, WA, United States and Richard Walter Fenrich, PhD, xStar Research, Blacksburg, VA

This open forum provides a technology exchange on methods and tools for integrated design, construction, and operations. This year's ASHRAE CIDCO Showdown model building will be used as an example and starting point for an open discussion in which all audience members are encouraged to participate and share their insights and challenges from previous design, construction, and operations projects and the tips, tricks, and tools that other practitioners may find valuable for their own projects.

1:30 PM - 3:00 PM

CIDCO Seminar 8 (Intermediate)

Resilience and Modelling Future Weather



Room: Grand Ballroom 2

Chair: Krishnan Gowri, PhD, Fellow Member, Intertek Inc., Bothell, WA

Designing the built environment to be resilient to impacts of adverse weather conditions is both an old and a new challenge. Some design considerations are familiar for mission critical facilities, but present and expected future conditions are making resilience more relevant for the built environment writ large. This seminar includes presentations discussing resilient design of systems in extreme heat and cold conditions at the building level, design guidance for resilience under expected future conditions at the community level, housing retrofits for resilience to overheating and air quality issues, and a resilience assessment methodology using key simulations with relevant case studies.

1. Temperature Projections: How Climate Change Impacts on Current and Future Extreme Heat Can Affect Heating and Cooling System Design

Jaclyn R Kinson, Associate, CDM Smith, Boston, MA

4. 5 Resilience Simulations to Make Better Buildings

Alexandra Lowrie Love, Affiliate, JLL, Charlotte, NC

1:30 PM - 3:00 PM

Seminar 41 (Advanced)

LIVESTREAM: Advancements of Low GWP Refrigerants

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 4

Sponsor: 10.7 Commercial Food and Beverage Refrigeration Equipment, 3.1 Refrigerants and Secondary Coolants

Chair: Vishaldeep Sharma, Eng, Full Member, Honeywell, Buffalo, NY

The quest for environmentally friendly refrigerants has accelerated in recent years due to growing concerns over global warming potential (GWP). Advancements in low-GWP refrigerant encompass various aspects, including thermodynamic properties, compatibility with existing equipment, safety considerations and environmental impact. In this session, roadmap of refrigerants for commercial refrigeration sector will be highlighted.

1. Overview of Refrigeration Technologies Using Natural and Synthetic Refrigerants

Samuel Yana Motta, Oak Ridge National Laboratory, Oak Ridge, TN

2. Path to Decarbonization for Supermarkets with Low GWP Refrigerants

Kaimi Gao, Associate, Honeywell, MINNEAPOLIS, MN

3. Exploratory Study on Optimized Heat Exchangers for Low-GWP Refrigerant Mixtures

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

Tuesday, June 25, 3:15 PM - 4:45 PM

CIDCO Panel 6 (Basic)

ASHRAE Fishbowl

Room: Grand Ballroom 1

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

A fishbowl panel discussion comes from a popular open fishbowl conversation format. Members of the audience sit on stage or in the center of the room to discuss a topic introduced by the panel moderator. At any time, any member of the audience can join the fishbowl panel by replacing an existing participant. The discussion continues with participants frequently entering and leaving the panel until the time is up. The moderator then summarizes the discussion.

3:15 PM - 4:45 PM

CIDCO Seminar 9 (Intermediate)

Energy Master Planning of a Geothermal Community



Room: Grand Ballroom 2

Sponsor: 7.3 Operation, Maintenance and Cost Management, 7.6 Building Energy Performance, 6.8

Chair: Jill Kurtz, Page Southerland Page, Inc., Weston Lakes, TX

Yampa Valley Housing Authority's master plan for workforce housing needed a complementary energy framework to inform the community horizontal and vertical energy infrastructure. The team developed a strategy to compare multiple systems including community geothermal and analyzing lifecycle costs, carbon, net zero potential, peak modeling, and community impact benefits. The team worked closely with the Yampa Valley Sustainability Council's, coordinated load calculations with Yampa Valley Electric Cooperative, and connected analysis to potential grants and funding streams. Presenters will discuss the complexity of community scale modeling, stakeholder engagement, early feasibility for geothermal master planning, and a triple bottom line analysis.

1. Introduction to YVHA, the workforce housing crisis, and the Brown Ranch Solution

Sheila Henderson¹ and **Jason Peasley²**, (1)Brown Ranch, (2)Yampa Valley Housing Authority

2. Coordinating the Plan: The Influence of Partners

Greg Tinkler, CGD, Full Member, Page/, Fulshear, TX

3. Calculating for the Plan: Modeling to Reveal the Right Approach

James Principe, Associate, Page, Weston Lakes, TX

4. Community Engagement and Costs of the Plan: Stakeholder Education, Triple Bottom Line Analysis, and Board Adoption

Catherine A Tinkler, EBCP, PMP, LEED AP O+M, Associate, Page Southerland Page, Inc., Weston Lakes, TX

3:15 PM - 4:45 PM

Seminar 42 (Intermediate)

LIVESTREAM: Changing World for Electric and Thermal Batteries

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 4

Sponsor: 6.9 Thermal Storage

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

Energy storage is essential if we are to achieve 100% renewable energy on the grid by 2025. While utility-scale electric batteries are under development, they remain prohibitively expensive. Behind-the-meter batteries, both electric and thermal, will help make the transition for buildings to electrify and decarbonize and ultimately be grid flexible.

1. Hybrid Batteries for Buildings: Electric and Thermal

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

2. Revolutionizing the Cold Chain: Leveraging Phase Change Materials for Electrification in Chilled Trucking and Refrigerated Trailers

Stan Nabonzy, Director of Thermal Energy Storage, Member, Michaels Energy, The Woodlands, TX

3. Survey of Utility Incentives and Promotional Rates for Thermal Batteries

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

Wednesday, June 26

Wednesday, June 26, 8:00 AM - 9:00 AM

CIDCO Keynote 3 (Intermediate)

The Role of Integrated Design For Advancing Near-Zero Industrial Campuses

Room: Grand Ballroom 5 & 6

Chair: Marianna Vallejo, PhD, Jacobs, Portland, United States Minor Outlying Islands

As integrated technology demands continue to grow across the globe, we've seen an increased demand for large-scale manufacturing and high-capacity data center campuses. Whether these campuses are greenfield construction or tackling the challenges of renovating and repurposing existing building stock, urban or rural, these projects represent some of the largest carbon and energy consumers in the built environment. This keynote considers the unique challenges and opportunities of implementing an integrated design approach for large-scale industrial campus projects. The presentation will explore the benefits of this approach in capturing and actualizing opportunities which allow these facilities to approach near-zero impact goals.

The Role of Integrated Design For Advancing Near-Zero Industrial Campuses

Marianna Vallejo, PhD, Jacobs, Portland, OR

8:00 AM - 9:30 AM

Panel 6 (Intermediate)

The Role of Machine Learning and AI in Indoor Environmental Modeling

Track: Artificial Intelligence and the Built Environment

Room: Grand Ballroom 3

Sponsor: 4.10 Indoor Environmental Modeling

Chair: Mark James Seymour, P.E., Full Member, Cadence Design Systems Inc., London, United Kingdom

Although the concept of artificial intelligence and machine learning has been around for many years, since the advent of chatbots for everyday life activities, the concept has seen tremendous acceleration in many walks of life. Simulation tools like those for indoor environment modelling have traditionally been criticized for their lengthy simulation times, complexity and heavy results analysis. AI can solve all these challenges – or can it? This panel discusses the practical uses of AI for indoor environmental modelling, and expose pitfalls and current limitations, as well as success paradigms.

1. Probabilistic Machine Learning Models for Indoor Environment Modeling

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

2. A Fast and Self-Learning Model for Indoor Environment Modeling

Wangda Zuo, Ph.D., S-B-a Member, Penn State University, MIDDLETOWN, PA

3. Generative Artificial Intelligence for Fast Prediction of Indoor Airflow Distribution

Cary Faulkner, Student, Pacific Northwest National Laboratory, Boulder, CO

4. Why Use AI for Indoor Environmental Modeling

Alexander Jerome Willman, PE, Full Member, AJWillman International LLC, CARLSBAD, CA, CA

8:00 AM - 9:30 AM

Conference Paper Session 16 (Basic)

Procedures and Equipment for Evaluating Building Technology Performance

Track: Research Summit



Room: Grand Ballroom 10

Chair: Ahmed Elatar, Oak Ridge National Laboratory, Associate, Oak Ridge National Laboratory, OAK RIDGE, TN

This diverse session explores different methods of evaluating RTUs, illuminance, load shifting, chiller modeling and vapor compression controls.

1. Missed Connections: How RTU Test Procedures Focus on Some Energy Saving Features and Ignore Others (IN-24-C042)

Bretnie Eschenbach, Full Member¹, Chris Keith Wolgamott, CEM, CDSM, Associate², Jason Jones², Wyatt Ogle³, David Salego³, Austin Schroeder³, Colleen Collins, Associate¹ and Rebecca Hovey⁴, (1)Cadeo Group, Seattle, WA, (2)Northwest Energy Efficiency Alliance, Portland, OR, (3)Aaon, Tulsa, OK, (4)Cadeo Group

2. Predicting Discomfort Glare Using Simple Illuminance Measurements: An Experimental Evaluation (IN-24-C043)

Shengbo Zhang, 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

2. Load Shifting and Maximizing Energy Cost Savings with Dynamic Ventilation Strategies in Multi-Family Residential Buildings (IN-24-C044)

Riwayat Katia, Student¹, Paul Raftery, PhD, Full Member², Carlos Duarte, Ph.D., Associate³ and Yan Wang, PhD², (1)University of California Berkeley, BERKELEY, CA, (2)Center for the Built Environment, UC Berkeley, Berkeley, CA, (3)UC Berkeley, Center for the Built Environment, Berkeley, CA

3. Development of Novel Chiller Modeling Strategies for a More Cost-Friendly Measurement & Verification Process for Chiller Retrofit Measures (IN-24-C045)

Martin Ssembatya, Mechanical Engineering, Student¹, Juan-Carlos Baltazar, BEMP, Member² and David E Claridge, Fellow Life Member³, (1)Texas A&M University, College Station, TX, (2)Texas A&M Engineering Experiment Station, College Station, TX, (3)Texas A&M University, COLLEGE STATION, TX

4. Air-Conditioning System Constraint Enforcement Using a Reference Governor (IN-24-C046)

Ganiyu ENIOLA Azeez, Ali Kashani and Claus Danielson, University of New Mexico, Albuquerque, NM

8:00 AM - 9:30 AM

Seminar 43 (Intermediate)

LIVESTREAM: Component and System Optimization for Lower-GWP Refrigerants

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 4

Sponsor: 1.13 Optimization, MTG.LowGWP Lower Global Warming Potential Alternative Refrigerants

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

The use of mathematically rigorous optimization methods plays a key role in transitioning the HVAC&R industry from refrigerants with high global warming potential (GWP) to those with lower- GWP and lower environmental impact. The transition requires re-design of components such as heat exchangers and compressors as well as system architectures. This session presents application of optimization methods for heat exchanger and heat pump system design. Also discussed are specific refrigerant blends such as the R454-series and the system modifications required to transition from R410A to its lower-GWP alternatives.

1. Multi-Objective Optimization of Low-GWP Mixture Composition and Heat Exchanger Circuitry for Improved System Performance and Reduced Refrigerant Flammability

Zhenning Li, PhD, Full Member, Oak Ridge National Laboratory, OAK RIDGE, TN

2. Low-GWP Options for R410A AC/HP Applications

Michael Petersen, Associate, Trane Technologies, Bloomington, MN

3. Design Optimization of Reversible Heat Pump System for Low-GWP Refrigerants

Henna Tangri, Associate, Honeywell, Minneapolis, MN

8:00 AM - 9:30 AM

Seminar 44 (Intermediate)

HVAC IoT Edge Controllers Are Here: What Can We Do with Them and What Are the Benefits?

Track: *Electrification: Possibilities and Pitfalls*



Room: Grand Ballroom 7

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

Chair: *Greg Pavlak, Ph.D., Member, The Pennsylvania State University, University Park, PA*

Full electrification of buildings and decarbonization of the electric grid will require advanced sensing, analytics, and controls. In support of this transition, commercial HVAC IoT edge controllers are becoming widely available, bringing advanced capabilities like Docker container support, AI accelerators, embedded APIs and substantial increases in computing power, I/O, and communications to the equipment and device-level. This seminar will unpack real-world examples of how these new capabilities can improve building performance and support efficiency and electrification, with the overall goal of helping building industry professionals better understand when, why and how they might leverage these advanced features.

1. Delivering Energy Efficiency and Grid Services Using an Opensource Iot Edge Device: Volttron

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

2. Predictive Maintenance via HVAC Iot Edge Devices

Greg Pavlak, Ph.D., Member, The Pennsylvania State University, University Park, PA

3. Iot Edge Devices: Real World Deployment Experience

Terry Herr, Full Member, Intellimation, LLC, Norristown, PA

8:00 AM - 9:30 AM

Seminar 45 (Intermediate)

New ASHRAE Standards 185.3, 145.4, and 185.5 for Air Cleaners – What are They and When to Use Them?

Track: *HVAC&R Systems and Equipment*



Room: Grand Ballroom 8

Sponsor: TG2.RAST Reactive Air and Surface Treatment, 2.4 Particulate Air Contaminants and Particulate Contaminant Removal Equipment, EHC, 2.3, 2.9, TRG:IAQP

Chair: *Kathleen Owen, Fellow Member, Owen Air Filtration Consulting, Cary, NC*

As highlighted in the new ASHRAE Standard 241, all air cleaners need standardized test results for efficacy and safety. Air cleaners that work in the room air have needed standard tests for pathogens and gases. It is important to test these air cleaners under standard, comparable conditions. ASHRAE's new tests cover in-room and duct-mounted air cleaners and how they impact the room air. This allows users to know how these air cleaners work and to include them in 241 and similar calculations. These new standards also include devices and technologies not previously covered in ASHRAE.

1. Understanding 185.3 Test Method; In-Room Air Cleaners

Linda D Lee, DrPH, Full Member, Linda D Lee Healthcare Consultants, Austin, TX

2. Measuring Gas Reduction in the Occupied Space with Commercial Air Cleaners (Standard 145.4P)

Caitlin D Naske, Full Member, Dynamic Air Quality Solutions, Princeton, NJ

3. Bioaerosol and Particle Reduction in Room Air By Duct-Mounted Air Cleaners (Standard 185.5)

Kathleen Owen, Fellow Member, Owen Air Filtration Consulting, Cary, NC

8:00 AM - 9:30 AM

Seminar 46 (Intermediate)

Your Ethics Tool Box: Building a Framework for Ethical Decision-Making With Case Studies

Track: *Workforce Development*



Room: Grand Ballroom 9

Sponsor: 1.7 Business, Management & General Legal Education

Chair: *Julia Timberman, PE, Full Member, Air Control Products, Columbus, OH*

ASHRAE members are often confronted with ethical issues (whether they realize it or not). This session is part of a continuing program under which ASHRAE members engage in an interactive session where participants are presented with multiple ethics cases, discuss the cases in small groups, and then reveal their decisions. Test your "Ethics IQ" against real cases and receive CE credit in the process.

1. Case Studies 1 & 2

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

2. Case Studies 3 & 4

Scott M Fanning, PE, Full Member, Fanning Fanning & Assoc, Lubbock, TX

3. Case Studies 5 & 6

Julia Timberman, PE, Full Member, Air Control Products, Columbus, OH

Wednesday, June 26, 9:45 AM - 10:45 AM

Panel 7 (Intermediate)

Regulation: It's Finally Hitting Fans

Track: Legislation, Standards, Codes, and Guidelines

Room: Grand Ballroom 3

Sponsor: 5.1 Fans

Chair: Michael Ivanovich, Full Member, AMCA, Arlington Heights, IL

Succinctly, fan efficiency is absolutely critical to decarbonization efforts. The U.S. Department of Energy estimates that commercial and industrial fans comprise approximately 13% of total U.S. annual electricity consumption, amounting to 305 GWh at a cost of \$34 billion per year. Fan-efficiency provisions have been in energy codes since 2013. Fan regulations were established by California in 2022 and a DOE test procedure in 2023. DOE's energy standard should be finalized in 2024. Experts on the California and DOE rulemakings and fan manufacturers discuss the requirements and impacts of these new regulations. Resources for compliance will also be provided.

1. Fan Regs1

Mark VanderKooy, Associate, Greenheck Fan Corporation, SCHOFIELD, WI

2. Fan Regs2

Christian R Taber, BEMP and HBDP, Full Member, Delta T Corporation dba Big Ass Fan Company, Lexington, KY

3. Fan Regs3

Laura G. Petrillo-Groh, PE, Full Member, AHRI, Arlington, VA

4. Fan Regs4

John Bade, Full Member, 2050 Partners, orinda, CA

9:45 AM - 10:45 AM

CIDCO Panel 7 (Intermediate)

Mandated Energy Performance: A Reasonable Step For Local Authorities to Take

Room: Grand Ballroom 1

Chair: Annie Smith, Introba, Florissant, MO, Mitchell Swann, P.E., Life Member, Resolution Management Consultants, Philadelphia, PA, Elizabeth K Tomlinson, PE, Full Member, Stantec, Calgary, AB, Canada and Michael P Deru, PhD, Full Member, NREL (National Renewable Energy Lab), Lakewood, CO

Many jurisdictions are setting hard targets for energy use in commercial buildings - either as EUI or CO2e limits. Benchmark reporting is one thing, but hard limits set a higher bar for performance, especially if there are financial penalties attached. Who is best able to ensure that targets are met or achieved? Should engineers be held responsible for the performance of their designs? Contractors for the quality of their construction? Owners for the quality of their operations? Who gets compensated if the targets aren't met? What would that look like? Come hear our panelists discuss the pros and cons.

Mandated Energy Performance

Annie Smith, PE, BEMP, Member, Introba, Florissant, MO

9:45 AM - 10:45 AM

CIDCO Panel 8 (Intermediate)

The Importance of Optimizing Distributed Energy Resources in Grid Interactive Buildings for Carbon Neutrality

Room: Grand Ballroom 2

Chair: Snowil Lopes, Clemson University, CLEMSON, SC, Ramtin Hadidi, Clemson University, Clemson, SC, Wayne Johnson, Duke Energy, Gregory Hudson, RMF Engineering, Inc. and Ian Colten, Davis and Plaumin Inc., Lexington, KY

For commercial and institutional buildings, decarbonization efforts like solar have slowed due to larger demand, rooftop complexities and cost benefit considerations. Yet, commercial and institutional buildings would benefit from newer technologies in distributed energy resources such as small hydro/wind turbines, solar PV, batteries, and on-premises recovery systems. These systems enable larger

buildings to distribute energy resources which can use and create energy behind the utility meter, store it for demand flexibility and feed energy into the grid when net positive. DER's can be connected for generation and distribution both locally and externally.

The Importance of Optimizing Distributed Energy Resources in Grid Interactive Buildings for Carbon Neutrality

Snowil Lopes, Clemson University, CLEMSON, SC

9:45 AM - 10:45 AM

Conference Paper Session 17 (Basic)

Building Life Cycle Analysis

Track: Research Summit



Room: Grand Ballroom 10

Chair: Michael Galler, Full Member, NIST Engineering Laboratory, Gaithersburg, MD

Papers in this session describe different aspects of understanding total building life cycle analysis.

1. Thermal Response of a Solar Photovoltaic Energy Storage System for Application in Buildings (IN-24-C047)

Aayushma Singh, Student and Emmanuel C Nsofor, Professor, S-B-a Member, Southern Illinois University, Carbondale, Carbondale, IL

2. Navigating the Global Landscape of Embodied Carbon: Challenges, Opportunities, and Best Practices (IN-24-C048)

Yee Ting Wong, Full Member, Arup, Hong Kong, China

3. Roles of Residential Water Heaters for Building Decarbonization: Literature (IN-24-C049)

Jonathan H Maxwell, Engineer in Training, Student¹, Zheng O'Neill, Ph.D., P.E., Fellow Member² and Zhiyao Yang, Ph.D., Associate¹,

(1)Texas A&M University, COLLEGE STATION, TX, (2)Texas A&M University, College Station, TX

9:45 AM - 10:45 AM

Seminar 47 (Intermediate)

Part I: An Overview of the Recently Released ASHRAE Design Guide for Commercial Kitchen Ventilation

Track: Fundamentals and Applications



Room: Grand Ballroom 7

Sponsor: 5.10 Kitchen Ventilation

Chair: Russell R Robison, Full Member, Gaylord Industries, Tualatin, OR

At the the 2023 ASHRAE Annual Conference, the ASHRAE Design Guide for Commerical Kitchen Ventilation (CKV) was released.

In the first part of this two-part seminar, the guide's authors will present on the topics of 1) an introduction to the CKV design process, 2) an overview of the elements which make up the CKV system, and 3) an assessment of the life cycle cost of your commercial kitchen.

1. Introduction to the Design Process for Commerical Kitchen Ventilation Applications

Andrew Re, Accurex, CARROLLTON, TX

2. Mastering Commercial Kitchen Ventilation: A Comprehensive Design Overview

Derek W Schrock, R&D Manager, Full Member, Halton Company, NASHVILLE, TN

3. Life Cycle Cost Components and Evaluation

Gregory B Duchane, Full Member, Trane, SAN JUAN, PR

9:45 AM - 10:45 AM

Seminar 48 (Intermediate)

LIVESTREAM: Renewable Fuels in Heating Equipment

Track: HVAC&R Systems and Equipment



Room: Grand Ballroom 4

Sponsor: 6.10 Fuels and Combustion

Chair: Jennifer Guerrero-Ferreira, Associate, Karl Dungs USA, Atlanta, GA

This seminar discusses the advantages of incorporating renewable fuels in heating equipment as part of a decarbonization strategy. These include reduced investment cost, meeting energy storage needs to address renewable power intermittency, resilience and achieving greenhouse gas reductions quickly.

1. Public Gas Supply and the Household Sector As a Booster for Hydrogen As an Energy Source

Gunther Gottfried Berthold, Full Member, Beckett Thermal Solutions, Formigine, Italy

2. How Can Hydrogen Help to Impact Climate Change

David A Searce, PE, Full Member, AZ Engineering, Kingston upon Hull, United Kingdom

3. The Future of Liquid Renewable Fuels with a Focus on the Net Zero Carbon Home

Thomas A Butcher, PhD, Fellow Life Member, Brookhaven National Laboratory, UPTON, NY

9:45 AM - 10:45 AM

Workshop 5 (Basic)

Buzzwords and Bias: Meeting in the Middle Advances the Whole

Track: Workforce Development



Room: Grand Ballroom 8

Sponsor: 1.7 Business, Management & General Legal Education, 7.3 Operation, Maintenance and Cost Management , 9.7 Educational Facilities

Chair: Jonathan Smith, PE, Full Member, HDR Engineers, Lenexa, KS

Climate terms - crisis, global warming, hoax and energy terms - renewable, clean and dirty are used in colloquial and professional speech. Social cost of carbon and environmental justice discussions may be at odds with stewardship, capital-cost control or conventional approaches. Rather than overwhelming others or tiptoeing around topics, can't discussions recognize and remove bias to meet in the middle of philosophical differences. Laying all the cards on the table with frank identification of industry terms, how terms are perceived by others, and what terms may indicate bias, participants are encouraged to practice conversations that promote listening and healthy debate.

1. Matching Terms to the Team

Catherine A Tinkler, EBCP, PMP, LEED AP O+M, Associate¹ and Rachel L Romero, PE, Full Member², (1)Page Southerland Page, Inc., Weston Lakes, TX, (2)NREL, LAKEWOOD, CO, United States

Wednesday, June 26, 11:00 AM - 12:00 PM

CIDCO Panel 9 (Basic)

Looking to the Future: Weather Data Opportunities and Challenges

Room: Grand Ballroom 1

Chair: Parag Cameron-Rastogi, PhD, CEng, MCIBSE, MASHRAE, Full Member, GRESB, Glasgow, United Kingdom

This panel discussion provides a comprehensive view of considerations, including opportunities and challenges, for the use of future weather data in design and analysis. This session showcases three different perspectives and highlights that not all future weather data is the same, and the many applications. Following the presentations, there will be time for discussion to align or find gaps, and questions including a call to action.

1. Machine Learning for the Creation of Future Weather Files in Building Physics Simulations

Parag Cameron-Rastogi, PhD, CEng, MCIBSE, MASHRAE, Full Member¹, Barbara Gao² and Elyse M Malherek, Associate³, (1)GRESB, Glasgow, United Kingdom, (2)Thornton Tomasetti, New York, NY, (3)Willdan, ANAHEIM, CA

11:00 AM - 12:00 PM

CIDCO Seminar 10 (Intermediate)

Solving Complex Design Challenges Using Computational Models and BIM Collaboration



Room: Grand Ballroom 2

Chair: Susan Collins, COO, Whole Building Systems, Mt Pleasant, SC

This session focuses on approaches to solving complex design challenges with respect to safety and comfort. Using computational models, design teams are improving fire protection safety for first responders. Occupants, are improving occupant comfort experiences in musical performance centers. Using a common data environment to collaborate on the expansion of a mass transit system serving millions of riders daily is also examined.

1. Moving Toward Smart Fire Protection: Develop a Protocol for Fire Protection Decision-Making Based on Building Information Model & Fire Dynamic Model

Xiaolei Chen¹ and Frank Wang, Senior Fire Protection Engineer², (1)California State University, Los Angeles, LOS ANGELES, CA, (2)Jensen Hughes, Los Angeles, CA

11:00 AM - 12:30 PM

Conference Paper Session 18 (Basic)

Advances in HVAC&R Systems

Track: Research Summit



Room: Grand Ballroom 10

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

Four studies are presented exploring advances in different elements of HVAC&R equipment.

1. Numerical Analysis of Forced Convection in an Open-Cell Metal Foam Used in Compact Heat Exchangers Using Fin Theory and Porous Media Approach (IN-24-C050)

Chaitanya Prasad Nanda¹, Metodi Zlatinov, Sr. Engineer² and Raj M Manglik, Professor, Fellow S-B-a Member¹, (1)University of Cincinnati, CINCINNATI, OH, (2)ERG aerospace corporation, Davis, CA

2. Performance Analysis of Vertical Borehole Ground Heat Exchanger Design Methods Using Modelica-Based Modeling and Simulation (IN-24-C051)

Nurayn Tiarniyu¹, Kevwe Andrew Ejenakevwe, Student¹ and Li Song, PhD, S-B-a Member², (1)University of Oklahoma, Norman, OK, (2)University of Oklahoma, NORMAN, OK

3. Parametric Analysis on Mitigation of Aerodynamic Noise Generated By Gas Discharge Process of Rolling Piston Compressor (IN-24-C052)

Yidan Cui, Student¹, Dazhuang He, Student², Davide Ziviani, PhD, Full Member² and Yangfan Liu, PhD², (1)Purdue University, W LAFAYETTE, IN, (2)Purdue University - Ray W. Herrick Laboratories, West Lafayette, IN

4. Retrofitting Application of EC Motor Plug Fans in HVAC Systems (IN-24-A007)

Nitesh Singh, Student¹, Indra Permana, Student¹, Renhong Chung, Student Member² and Fugen Wang, Ph.D., P.E., Fellow ASHRAE¹, (1)National Chin-Yi University of Technology, Taichung, Taiwan, (2)National Chin-yi university of technology, Taichung district, Taiwan

11:00 AM - 12:30 PM

Seminar 49 (Intermediate)

Current Legislation of Gas Stoves: What Is The Impact and How Should We Proceed?

Track: Legislation, Standards, Codes, and Guidelines



Room: Grand Ballroom 3

Sponsor: 2.3 Gaseous Air Contaminants and Gas Contaminant Removal Equipment, 2.4 Particulate Air Contaminants and Particulate Contaminant Removal Equipment

Chair: John Randtke, P.E., Full Member, Schneider Electric, Kansas City, MO

The use of gas stoves is starting to be limited in some municipal jurisdictions throughout the country. This seminar explains some of the rationale for these restrictions, explore the IAQ benefits, and explain some of the challenges of following this path.

1. Banning Gas Stoves is Too Fast and Too Furious

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

2. Gas Stoves in America's Most Populated City

Scott Sherwood, Full Member, Eco Care Corporation, NEW YORK, NY

3. Current State of Research of Gas Stoves on the Indoor Environment

Brandon Emil Boor, Associate Professor, Associate, Purdue University, West Lafayette, IN

11:00 AM - 12:30 PM

Seminar 50 (Intermediate)

LIVESTREAM: Navigating Building Electrification, Demand Management and Renewable Energy Programs Working Together: Promises and Pitfalls

Track: Electrification: Possibilities and Pitfalls



Room: Grand Ballroom 4

Sponsor: 7.5 Smart Building Systems

Chair: Michael R Brambley, PhD, Fellow Life Member, Pacific Northwest National Laboratory, Richland, WA

Electric utilities and government organizations offer numerous programs for buildings. They assist with energy efficiency and renewable energy investments, demand management that can lower electricity costs while reducing stress on the grid, and most recently, electrification of building end uses to both increase energy end-use efficiency and decarbonize energy use as the grid moves rapidly

toward mostly renewable generation. This seminar, through examples, shares information on programs, their benefits, the opportunities they create, and in some cases the challenges they present. Three perspectives are represented: a homeowner, a utility and a federal agency.

1. Demand Management Experiences behind the Meter...and Enemy Lines?

Clay G Nesler, Full Member, The Nesler Group, Fort Meyers, FL

2. Energy Efficiency & Demand Response Go Hand and Hand

Jeannette D Staden, OG&E, Oklahoma City, OK

3. Teaching Federal Buildings to Play Well with the Grid

Kinga Porst Hydras, Member, GSA - U.S. General Services Administration, Washington, DC

11:00 AM - 12:30 PM

Seminar 51 (Intermediate)

Ongoing Research into Developing an IEQ Metric(s)

Track: Legislation, Standards, Codes, and Guidelines



Room: Grand Ballroom 7

Sponsor: 2.1 Physiology and Human Environment, SPGC10, EHC

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

ASHRAE's Mid Strategic plan #2 initiative area calls for the development of a standard addressing air quality, thermal environment, light, sound, and vibration in an integrated way. Guideline 10 is the start to the development of this IEQ Standard; however, what is missing to development and IEQ Standard is a metric to determine the success of meeting the standard. Ideally such a standard and metric would sustain and possibly improve the health of the building occupants so should this metric be health-based. This seminar will discuss ongoing research to develop a metric for an IEQ standard.

1. Need to Develop an IEQ Metric to Meet Ashrae Initiative 2, Development of an IEQ Standard.

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

2. Unified Scales for the Harm and Discomfort of IEQ Effects

Richard Bruns, Economist of Public Health, JHU Center for Health Security, Baltimore, MD

3. Quantifying the Health Impact of IAQ

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

4. Beyond Building Energy Efficiency - Exploring the Influence of Combined Indoor Environmental Stimuli on Occupant Comfort, Wellbeing, and Health

Giorgia Chinazzo, PE, Associate, Northwestern University, Evanston, IL

5. Measuring Carbon Monoxide As a Metric of Air Quality and Environmental Stress

Albert H Donnay, Toxicologist, Full Member, Retired, Hyattsville, MD

11:00 AM - 12:30 PM

Seminar 52 (Intermediate)

Part II: An Overview of the Recently Released ASHRAE Design Guide for Commercial Kitchen Ventilation

Track: Fundamentals and Applications



Room: Grand Ballroom 8

Sponsor: 5.10 Kitchen Ventilation

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

At the 2023 ASHRAE Annual Conference, the ASHRAE Design Guide for Commercial Kitchen Ventilation (CKV) was released. In the second part of this two-part seminar, the guide's authors will present on the topics of 1) Hood Selection, 2) Fan Selection, 3) Exhaust Duct Design and 4) Air Balancing and Commissioning.

1. Scaling Your Commercial Kitchen Ventilation System with an Engineered Hood System

Russell R Robison, Full Member, Gaylord Industries, Tualatin, OR

2. Exhaust Fans for Commercial Kitchen Ventilation Applications

Andrew Re, Accurex, CARROLLTON, TX

3. Type 1 Hood Exhaust Duct (aka Grease Duct) for Commercial Kitchens

Keith Page, Member, Selkirk/Hart & Cooley (c/o Duravent Group), Detroit, MI

4. Air Balance and Commissioning for Commercial Kitchen Ventilation Applications

Jason R Brown, Associate, Melink Corporation, MILFORD, OH

11:00 AM - 12:30 PM

Seminar 53 (Basic)

Rooftop Equipment: Support, Noise Control and Restraint

Track: Fundamentals and Applications



Room: Grand Ballroom 9

Sponsor: 2.6 Sound and Vibration, 2.7 Seismic, Wind and Flood Resistant Design

Chair: Karl L Peterman, PE in 50, INCE Bd Cert, Full Member, Swegon North America / Vibro-Acoustics, by Swegon, Ajax, ON, Canada

This session covers common HVACR components that are often located on building roofs and discusses proper methods to support and secure them to the structure in accordance with building code requirements and explain effective methods to mitigate airborne and structure-borne noise problems. A case study will be presented that addresses various common issues found with rooftop systems.

1. Support, Isolation and Restraint for Curb-Mounted Equipment

John P Giuliano, Full Member, VMC Group, BLOOMINGDALE, NJ

2. Airborne Noise Control for Rooftop Equipment

Karl L Peterman, PE in 50, INCE Bd Cert, Full Member, Swegon North America, Westampton, NJ

3. Rooftop Equipment Best Practices in Noise-Sensitive Applications

Brandon W Cudequest, Associate, Threshold Acoustics, Chicago, IL