



## 2022 WINTER CONFERENCE AND AHR EXPO

# 2022 ASHRAE Winter Conference Technical Program

January 30 - February 2, 2022

Last Updated: 1/25/2022

**Sunday, January 30**

Sunday, January 30, 8:00 AM - 9:00 AM

### Paper Session 1

#### **Virtual: Effect of Occupant Behavior and Occupancy Schedules on Buildings Energy Use and Consumption**

*Track: Buildings at 360°*



*Chair: Som Shrestha, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN*

Most current heating and cooling load estimation methods use simple approach to evaluate zone occupancy density which leads to an over estimation of the HVAC load and the need to use bigger equipment with a higher carbon footprint or to underestimate the load, which results in a lower comfort sensation. This session highlights the direct effect of occupancy rate coupled with occupants schedules. The session also explores the interaction between the occupants behavior and energy efficiency in buildings.

#### **1. How Household Characteristics Affect District Occupancy Schedules? A Case Study Using Canadian Time Use Survey Data (LV-22-C002)**

*Mohamed Osman<sup>1</sup> and Mohamed Ouf, Associate Member<sup>2</sup>, (1)Concordia University, Montréal, QC, Canada, (2)Concordia University, Montreal, QC, Canada*

#### **2. Developing an Automated Workflow for Non-Residential Building Retrofit as a Function of Usage (LV-22-C003)**

*Mostafa M. Saad, Sanam Dabirian, Kartikay Sharma and Ursula Eicker, Concordia University, Montreal, QC, Canada*

8:00 AM - 9:00 AM

### Seminar 1 (Basic)

## Codes and Design Standards for Motors and Motor Control Technology

Track: HVAC&R Systems and Equipment



Room: Milano V-VII

**Sponsor: 1.11 Electric Motors and Motor Control, 2.7 Seismic and Wind Resistant Design , TC 1.9 Electric Systems**

Chair: Nicolas S. Rosner, P.E., Member, Schneider Electric, Costa Mesa, CA

Today's global supply shortage, labor and transportation challenges have increased popularity of UL508A solutions. OSHA, NEC, UL, IBC, ASCE7 and OSHPD have set crucial standards for electrical panel design, motor and motor control basics, safety, as well as short circuit current rating standards. The purpose of this session is to understand these governing codes and how to apply them when designing motor control technology. Leading industry experts in the electrical and mechanical segment provide a general overview of control panel regulations as well as motor shake testing.

#### 1. UL 508A Industrial Control Panels and Code Requirements of NFPA70/79/70E

John Ross, Eaton, Cleveland, OH

#### 2. Seismic Certification of Motors

John Giuliano, P.E., Member, Vibration Mountings & Controls, Bloomingdale, NJ

8:00 AM - 9:00 AM

### Seminar 4 (Intermediate)

## Opportunities and Barriers for Self-Powered and Integrated HVAC

Track: Energy System Integration



Room: Augustus III/IV

**Sponsor: 6.10 Fuels and Combustion**

Chair: Paul Sohler, Crown Boiler Company, Philadelphia, PA

Integration between fuel-fired and electric heating and air conditioning systems is an established approach for minimizing the environmental impact of these end uses while providing superior comfort and lower operating costs. By further coupling these systems with power-generating equipment and grid-interaction, the overall integrated energy systems also gain superior resilience and grid flexibility. This seminar presents an overview of opportunities for and specific implementations of integrated and self-powered heating, cooling and water heating systems.

#### 1. Gas-Electric Self-Powered, Hybrid and Grid-Interactive Energy Systems

Tim Kingston, Associate Member, Gas Technology Institute, Des Plaines, IL

#### 2. Thermionic Converters for Self-Powered Residential Heating

Vikas Patnaik, Ph.D., Associate Member, Modern Electron, Bothell, WA

8:00 AM - 9:00 AM

### Forum 1

## Will High ACH Reduce the Spread of Airborne Contaminants

Track: Environmental Health and IEQ in the International Arena

Room: Neopolitan III/IV

**Sponsor: MTG.ACR, 1852**

Chair: Jim Coogan, P.E., Member, Engineered Air Balance, Houston, TX

It is generally believed that increasing the air change rate will automatically reduce the airborne contaminants in a room. More than the air change rate (ACR), would the effectiveness of ventilation play a more important role than ACR? Does the location of supply and return grille make a significant difference? This is an interactive brainstorming session and active participation of the audience is required.

Sunday, January 30, 9:45 AM - 10:45 AM

### Paper Session 2

## Indoor Environmental Quality Challenges in Public Places: Study Results from a College, School and Residential Kitchens

Track: Environmental Health and IEQ in the International Arena



Room: Neopolitan I/II

Chair: Suzanne LeVisieur, Haddad Engineering, Inc., Jacksonville, FL

This session covers three studies looking at indoor environmental quality challenges. The first paper presents the results and conclusions to inform the university for the design of new buildings, retrofitting old buildings and determining ventilation strategies for older buildings that are not slated for retrofitting. The second paper is an approach to estimate occupant density, outdoor air ventilation rates and supply airflow rates through the school by analyzing the decay, steady-state and accumulation periods of CO2 measured in return air. The third papers reviews criteria for evaluating residential kitchen IAQ and hood performance

**1. Indoor Conditions in Higher Education: A Survey of College Students on the California Central Coast (LV-22-C004)**

*Jennifer Mott, Ph.D., Associate Member, Khanhthy Le, Tarnvir Dhaliwal and Carly Tudor, California Polytechnic State University, San Luis Obispo, CA*

**2. Determining Airflows and VOC Source Strengths for an Occupied School (LV-22-C006)**

*Brett Stinson, Student Member, Aurélie Laguerre and Elliott Gall, Ph.D., Portland State University, Portland, OR*

**3. Evaluating Residential Kitchen IAQ and Hood Performance (LV-22-C056)**

*Rich Swierczynna, Member<sup>1</sup>, M. Frank G. Johnson, Ph.D., Member<sup>1</sup>, Jason Lafleur<sup>1</sup> and Jason Stein<sup>2</sup>, (1)Gas Technology Institute, Des Plaines, IL, (2)GTI, Des Plaines, IL*

9:45 AM - 10:45 AM

**Paper Session 3**

**Saving Energy and Water by Modelling**

*Track: Fundamentals and Applications*



Room: Milano V-VII

Chair: Gary Debes, Gary Debes Consulting Services, Coatesville, PA

Energy and water are two of the most important resources we need to use wisely. The papers in this session describe how a HVAC system can be designed to minimize the input energy, and how the associated operative costs can be estimated. The session will also investigate how water used by data centers can be estimated and measured to identify the best cooling solution that delivers the required heat gain mitigation while minimizing water draw.

**1. Characterizing Data Center Cooling System Water Stress in the United States (LV-22-C008)**

*Li Chen and Aaron Wemhoff, Ph.D., Associate Member, Villanova University, Villanova, PA*

9:45 AM - 10:45 AM

**Seminar 6 (Intermediate)**

**High Performance Design for Mega Airport Terminals**

*Track: Buildings at 360°*



Room: Augustus V/VI

**Sponsor: 9.8 Large Building Air-Conditioning Systems, 2.10 Resilience and Security**

Chair: Anthony York, P.E., Member, Syska Hennessy Group, New York, NY

New state-of-the-art mega airport terminals are large multi-use facilities that not only serve as transportation hubs for travelers, but they have become iconic buildings that command latest technologies in achieving LEED and other sustainability and resilience goals. These buildings require careful engineering integration with architectural design as well as functional program requirements specific to the owners and stakeholders of each airport. This seminar presents unique challenges and innovative solutions in the HVAC design associated with high performance design for airport terminals.

**1. Challenges in Design of Modern Airport Terminals**

*Kasteny Knutson, Syska Hennessy Group, New York, NY*

**2. Sustainability and Resilient Design in Airport Environment**

*Kris Baker, P.E., Syska Hennessy Group, New York, NY*

9:45 AM - 10:45 AM

**Seminar 7 (Basic)**

## Introduction of Building Decarbonization

*Track: Building Decarbonization*

*Room: Milano I-III*

**Sponsor: Task Force on Building Decarbonization**

*Chair: Doug Cochrane, P.E., Member, Carrier, Toronto, ON, Canada*

An introduction to decarbonization including fundamentals, common terms, and a review of the ASHRAE position document on Decarbonization, as well as next steps.

### **1. Building Decarbonization Update I & II**

*Don Brandt, Member<sup>1</sup> and M. Ginger Scoggins, P.E., Member<sup>2</sup>, (1)ASHRAE Design ESSENTIALS Instructor, Atlanta, GA, (2)Engineered Designs Inc., Raleigh, NC*

### **Building Decarbonization Update III**

*Kent W. Peterson, P.E., BEAP, Presidential Fellow ASHRAE, P2S Inc., Long Beach, CA*

9:45 AM - 10:45 AM

## Seminar 8 (Intermediate)

## The Solar Panel: Enabling Renewable's Integration with Thermal Energy Storage Systems

*Track: Energy System Integration*



*Room: Neopolitan III/IV*

**Sponsor: 6.9 Thermal Storage**

*Chair: Amy Van Asselt, Ph.D., Associate Member, Lafayette College, Easton, PA*

Integrating variable renewable electricity on the grid requires system flexibility. This flexibility can come from several building end-uses, but it should not impact occupant comfort, safety or product quality. This is possible by using thermal energy storage, which enables load flexibility of HVAC&R loads while still delivering the cooling or heating when needed. This session presents three thermal storage applications that reduce utility costs for building owners while also providing the flexibility that the grid needs for higher renewable penetration. The presenters describe how controls are critical to facilitate renewable electricity generation, and, in one application, electric vehicle charging.

### **1. Optimization of Photovoltaic Self-Consumption with Residential Electric Water Heaters**

*Celeste Fieberg, Student Member, Lafayette College, Easton, PA*

### **2. Enabling Grid Penetration of Renewables with Residential Cool Thermal Energy Storage**

*Amy Van Asselt, Ph.D., Associate Member, Lafayette College, Easton, PA*

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

## Paper Session 4

## How to Achieve the Desired Comfort Level in Extreme Weather Conditions

*Track: Buildings at 360°*



*Room: Augustus V/VI*

*Chair: Nohad Boudani, PEng, Member, Sodicom, Beirut, Lebanon*

Extreme weather conditions "too hot or too cold" represent a challenge when dealing with desired comfort level. Approaches to achieve the desired comfort level are presented during this session. Approaches include: the use of an electric heat pump water heater that can efficiently replace the traditional electric water heater; passive building strategies that can be integrated in modern building designs; manipulating the electric load by using "grid-interactive efficient buildings"; changing the set point and novel DC-powered picogrid coupled with on-site renewable energy generation, such as solar and wind power to drive real-time electrical management decisions.

### **1. Detailed Analysis of the Loads Impact of Passive Architectural Elements in Hot-Dry Climates (LV-22-C011)**

*Ahmed Mezaien, Student Member and Juan-Carlos Baltazar, Ph.D., P.E., BEMP, Member, Texas A&M University, College Station, TX*

11:00 AM - 12:30 PM

**Paper Session 5**

**Simulation, Integration and Optimization of Decentralized Energy into District Systems**

*Track: Energy System Integration*



*Room: Milano V-VII*

*Chair: Gary Debes, Gary Debes Consulting Services, Coatesville, PA*

Global decarbonization and net-zero targets require improved research for the simulation, integration and optimization of renewable energy usage. The papers in this session describe energy fluctuations of decentralized solar thermal collectors connected district heating to solve overheating; stagnation and energy losses of independent systems; investigate the maximization of waste heat recovery by modelling the coupling of thermal energy storage with a district-scale heat pump, based upon time-of-use electricity prices and recovering waste heat from the London Underground; provide a simulation with first order investigation of co-generation and tri-generation systems and their integration with renewable energy and storage systems; and simulate use testing of hybrid and grid-interactive integrated energy systems to balance energy grid supply and demand while exploiting multiple energy resources.

**1. Integrating Waste Heat Recovery from Railway Tunnels into Flexible Heat Networks (LV-22-C013)**

*Henrique Lagoeiro<sup>1</sup>, Akos Revesz, Ph.D., Affiliate<sup>1</sup>, Gareth Davies, Ph.D.<sup>1</sup>, Daniel Curry<sup>2</sup>, Gareth Faulks<sup>1</sup>, Declan Murphy<sup>2</sup>, Josh Vivian<sup>2</sup> and Graeme Maidment, Ph.D., P.E.<sup>1</sup>, (1)London South Bank University, London, United Kingdom, (2)Transport for London, London, United Kingdom*

**2. Demonstration and Analysis of Hybrid and Grid-Interactive Integrated Energy Systems Approaches (LV-22-C015)**

*Tim Kingston, Associate Member, Alejandro Baez-Guada and Alex Fridlyand, Ph.D., Associate Member, Gas Technology Institute, Des Plaines, IL*

11:00 AM - 12:30 PM

**Seminar 10 (Intermediate)**

**Building-Integrated Indoor Air Quality Sensors**

*Track: Environmental Health and IEQ in the International Arena*



*Room: Milano I-III*

**Sponsor: 7.5 Smart Building Systems, 6.10 Fuels and Combustion**

*Chair: Zachary Siefker, Student Member, Purdue University, West Lafayette, IN*

Current efforts in building science include the development of low-cost, low-power and high reliability sensing systems, capable of accurately quantifying indoor air quality (IAQ) metrics. Such information is of high value for model development, building energy management and improving occupant health and comfort. However, the widespread use of building-integrated IAQ sensors has yet to be fully realized. This seminar reviews recent developments in building-integrated IAQ sensing systems. Novel sensing technologies, best practice evaluation protocols used to assess the accuracy and reliability of IAQ sensors and end-use IAQ sensing applications are reviewed.

**1. Development and Evaluation of Low-Cost IAQ Sensors**

*Zachary Siefker, Student Member, Purdue University, West Lafayette, IN*

**2. Developing CO2 Sensor System Reliability Evaluation Methods for Commercial Building Applications**

*Kristen Cetin, Ph.D., P.E., Member and Debrudra Mitra, Michigan State University, East Lansing, MI*

**3. An Application of Kitchen Indoor Air Quality Sensors in Phius+ and Energy STAR Multifamily Units**

*Rich Swierczynna, Member, Gas Technology Institute, Des Plaines, IL*

11:00 AM - 12:30 PM

**Seminar 11 (Basic)**

**Introduction to Research Knowledge and Building Standards Working Groups**

*Track: Building Decarbonization*

*Room: Neopolitan III/IV*

**Sponsor: Task Force for Building Decarbonization**

*Chair: Doug Cochrane, P.E., Member, Carrier, Toronto, ON, Canada*

This session is an introduction to the Research Knowledge and Building Standards working groups of the Task Force on Building Decarbonization

**1. Research/Knowledge Hub for Building Decarbonization**

*Drury Crawley, Ph.D., BEMP, Fellow ASHRAE, Bentley Systems, Inc., Washington, DC*

**2. Building Performance Standard: The Pathway to Decarbonize the Existing Building Stock-Part I**  
*Bing Liu, P.E., Fellow ASHRAE, Pacific Northwest National Laboratory, RICHLAND, WA*

**3. Building Performance Standard: The Pathway to Decarbonize the Existing Building Stock-Part II**  
*Harry Bergmann, U.S. Department of Energy, Washington, DC*

11:00 AM - 12:30 PM  
**Seminar 12 (Advanced)**

## Renewables and the Smart Grid

*Track: Energy System Integration*



*Room: Neopolitan I/II*

**Sponsor: 7.5 Smart Building Systems, 6.7 Solar Energy Utilization , 7.6 Building Energy Performance and 2.8 Building Environmental Impacts and Sustainability**

*Chair: Christie Kjellman, Member, Kliever & Associates, Aliso Viejo, CA*

Renewable energy resources are nearly 20% of the U.S. generation mix, growing rapidly through advanced technology and state policy changes. Matching these accelerations in the energy markets are the emerging developments at the distribution level, also known as the “Smart Grid”. While electric customers are now both consuming and generating electricity, the Smart Grid and buildings will both need to dynamically respond to manage resources, loads and reliability. This session presents a variety of approaches used to optimize and integrate renewables and the Smart Grid.

### 1. Microgrid Applications

*Mehdi Ganji, Ph.D., Willdan, San Francisco, CA*

### 2. Field Demonstration of Optimal Control for Campus Cooling Plant for Renewable Energy Integration and Decarbonization

*Donghun Kim, Ph.D., Member, Lawrence Berkeley National Laboratory, Berkeley, CA*

### 3. Integration of Renewables and the Smart Grid

*Randall Higa, P.E., Member, Southern California Edison, Rosemead, CA*

Sunday, January 30, 1:30 PM - 3:00 PM  
**Paper Session 6**

## Energy Codes, Standards, Emission Trading Scheme to Achieve NetZero in 2050

*Track: Buildings at 360°*



*Room: Augustus V/VI*

*Chair: Gary Debes, Gary Debes Consulting Services, Coatesville, PA*

This session presents the efforts and major findings toward achieving the NetZero carbon emission goal in 2050. The session casts a light on what has been achieved and reviews future planning. Several aspects are evaluated from having a better understanding of the impact of implementing energy codes, updating energy standards and integrating new approaches that can reduce the GHG emissions to mitigate the global warming and anthropogenic impact on the environment. The well-being and comfort of humans are the ultimate priority which cannot be achieved unless joint efforts are combined.

### 1. Integrative Economic Analysis of Office Building HVAC Systems Incorporating the Emission Trading Scheme (LV-22-C016)

*Hyeonsoo Kim, Ph.D., Student Member and Lars Junghans, Ph.D., Associate Member, University of Michigan, Ann Arbor, MI*

### 2. Planning for Net Zero By 2050, What HVAC System Interventions Will Today's Code Minimum Commercial Buildings Require? (LV-22-C017)

*Patrick Pease, P.E., Member, Libu Babu, Jayati Chhabra and Zahra Zolfaghari, cove.tool, Atlanta, GA*

### 3. Expanding the Role of Energy Codes to Meet Generational Shifts (LV-22-C018)

*Kim Cheslak, Member<sup>1</sup>, Jim Edelson, Member<sup>2</sup>, Alexi Miller, P.E., Member<sup>2</sup> and Mark Lyles<sup>2</sup>, (1)NBI, Portland, ME, (2)New Buildings Institute, Portland, OR*

1:30 PM - 3:00 PM

**Paper Session 7**

**Recent Advancement in Heat Pump and Heating Systems**

*Track: HVAC&R Systems and Equipment*



*Room: Milano V-VII*

*Chair: Suzanne LeViseur, Haddad Engineering, Inc., Jacksonville, FL*

This session focuses on improving the HVAC system efficiency, achieving energy and cost savings and reducing GHG emissions by simulating or developing new heat pump and heating systems. The papers in this session estimate combined HVAC system annual efficiency, investigates operating costs & GHG emissions using virtual test home (VTH) method, which helps engineers select efficient systems; explains thermal energy storage integrated heat pump systems to meet the residential building's thermal demand while reshaping its electricity load profile; describes modeling results of a novel EHP water heating application and uses VTH test methods and modeling for assessing as-installed performance of HVAC and water heating systems.

**1. Combined Cold-Climate Air-Source Heat Pump and Heat Pump Water Heater System Performance in Multiple Climate Zones (LV-22-C019)**

*Alejandro Baez Guada, Member<sup>1</sup> and Tim Kingston, Associate Member<sup>2</sup>, (1)Gas Technology Institute, Chicago, IL, (2)Gas Technology Institute, Des Plaines, IL*

**2. Ejector Heat Pump for Water Heating (LV-22-C020)**

*Ahmad Abuheiba, Member<sup>1</sup>, Kashif Nawaz, Ph.D., Member<sup>1</sup>, Hongbin Ma, Ph.D.<sup>2</sup>, Pengtao Wang<sup>2</sup>, Jeremy Spitzenberger<sup>3</sup> and Stephen Kowalski, Member<sup>1</sup>, (1)Oak Ridge National Laboratory, Oak Ridge, TN, (2)Missouri University, Columbia, MO, (3)University of Missouri, Columbia, MO*

**3. A Novel Approach to Determining As-Installed Space and Water Heating Equipment Performance and Quantifying Potential Energy and Cost Savings in Buildings (LV-22-C021)**

*Alejandro Baez Guada, Member<sup>1</sup> and Tim Kingston, Associate Member<sup>2</sup>, (1)Gas Technology Institute, Chicago, IL, (2)Gas Technology Institute, Des Plaines, IL*

1:30 PM - 3:00 PM

**Seminar 9 (Basic)**

**Accelerating Change in Building Design and Operation for a Resilient Future**

*Track: Buildings at 360°*



*Room: Milano I-III*

**Sponsor: 7.1 Integrated Building Design, CIBSE ASHRAE Liaison Committee**

*Chair: Tim Dwyer, CEng, Fellow ASHRAE, UCL Institute for Environmental Design and Engineering (IEDE), London, United Kingdom*

This seminar illustrates how readily adoptable and accessible changes to the status quo of systems design and operation can deliver buildings that are healthier, more productive and more resilient, potentially providing a route towards a decarbonized and net-zero energy future. This includes applying digitally integrated tools; employing available techniques to 'decarbonize' built environments towards net-zero energy; revolutionary changes in the design of lighting for 21st century buildings rather than being constrained by legacy paradigms; and how a strategic, automated approach to the operation of buildings can optimize energy efficiency, minimize GHG emissions and maximize occupant comfort.

**1. Improving Building Performance with Intelligent Optimization**

*David Green, P.E., BCxP, Member, Integral Group, Edmonton, AB, Canada*

**2. Achieving Zero Energy**

*Tom Phoenix, P.E., BEMP, Presidential Fellow Life Member, Mechanical Contractors, Inc, Charlotte, NC*

1:30 PM - 3:00 PM

**Seminar 13 (Intermediate)**

**Expansion Devices 101: What Options Are There and Which One to Choose?**

*Track: HVAC&R Systems and Equipment*



*Room: Augustus III/IV*

**Sponsor: 8.8 Refrigerant System Controls and Accessories**

Chair: Christian Bach, Ph.D., Associate Member, Oklahoma State University, Stillwater, OK

Expansion devices are a ubiquitous but often overlooked device common to all vapor compression systems. They are selected based on the size of the system, the application type, as well as the refrigerant. Smaller scale applications typically use fixed devices, but with increases in size and the addition of variable speed compressors, means to actively control the refrigerant flowrate are implemented. Large scale and high-pressure applications use ejectors to further improve the system's energy efficiency. This seminar provides an overview of the different devices function, their design and their application range in a compact format.

**1. Thermostatic Expansion Valves: Basics and Application**

*Everardo Cano, Associate Member, Sporlan Division of Parker Hannifin, Washington, MO*

**2. Fixed Area Expansion Devices: Basics and Application**

*William V. (Vance) Payne, Ph.D., Member, National Institute of Standards and Technology, Gaithersburg, MD*

**3. Operation of Electronic Expansion Valves and Their Use for Efficient HVAC System Operation**

*Kirk Stifle, P.E., Member, Fujikoki America, Dallas, TX*

**4. Two-Phase Refrigerant Ejector: An Expansion Device Capable of Recovering Work**

*Stefan Elbel, Ph.D., Member, University of Illinois at Urbana-Champaign, Urbana, IL*

1:30 PM - 3:00 PM

**Workshop 1 (Basic)**

**Role Models: How to Inspire the Next Generation of Engineers**

*Track: HVAC&R Systems and Equipment*

*Room: Neopolitan III/IV*

*Chair: Catarina Marques, Ph.D., London South Bank University, London, United Kingdom*

Refrigeration employs 15 million people worldwide and the need for RACHP professionals is increasing due to a growing demand for cooling. Role models are paramount to highlight the career opportunities in RACHP and a diverse workforce benefits the industry. Companies with inclusive business cultures see a 59% increase in innovation and 37% better assessment of consumer demand. With climate change as a major challenge to tackle, promoting diversity, equality and inclusion (DEI) has never been more important or timely. This workshop explores benefits of DEI in the refrigeration industry, showing how role models can inspire the next generation of engineers.

**1. How to Inspire the Next Generation of Engineers**

*Catarina Marques, Ph.D., London South Bank University, London, United Kingdom*

**2. Promoting RACHP in Schools**

*Graeme Maidment, Ph.D., P.E., London South Bank University, London, United Kingdom*

**3. Benefits of Diversity, Equality and Inclusion in the Refrigeration Industry**

*Stephen Gill, World Refrigeration Day, Derby, CA, United Kingdom*

**4. Role Models Influence of Young People Career Decisions: Case Studies**

*Ina Colombo, Ph.D., International Institute of Refrigeration, Paris, France*

**5. Women in RACHP and Montreal Protocol Gender Policy**

*Ayman Eltalouny, Member, UNEP, Bahrain, Bahrain*

**6. A Young Engineer Perspective**

*Lucy Sherburn, Fairheat, London, United Kingdom*

Sunday, January 30, 3:15 PM - 4:15 PM

**On-Demand Paper Session (Intermediate)**

**Live Q&A Session 1: Improving Operational and Energy Efficiency of Building Heating and Cooling**

*Chair: Ahmed Abdelsalam, Amazon, Dublin*

**1. Real-Time Search for Optimum Operation Parameters of Air Conditioning System in the Data Center by Using Regression Prediction and Deep Reinforcement Learning on CFD Analysis Data (LV-22-C034)**

*Hiroki Tsukamoto<sup>1</sup>, Yuki Sogawa<sup>1</sup>, Kazuhiro Matsuda<sup>1</sup>, Morito Matsuoka<sup>1</sup>, Keisuke Otani<sup>2</sup> and Kazunari Momose<sup>2</sup>, (1)Osaka University, Osaka, Japan, (2)Advanced Knowledge Laboratory Inc., Tokyo, Japan*

**2. A Framework for a Multi-Sourced, Data-Driven Building Energy Management Toolkit (LV-22-C029)**

*Andre Markus, Student Member, Brodie Hobson, Student Member, Burak Gunay, Ph.D., Associate Member and Scott Bucking, Ph.D., Associate Member, Carleton University, Ottawa, ON, Canada*

**3. Potential Energy Savings By Switching Residential Electric Water Heaters to Electric Heat Pumps Water Heaters in Saudi Arabia (LV-22-C067)**

*Ayman Youssef, P.E., Member and Ghadah Alamer, Saudi Aramco, Dhahran, Saudi Arabia*



#### 4. Performance Analysis of Novel Thermal Storage Integrated Heat Pump System in a Residential Building for Demand Flexibility (LV-22-C066)

**Liang Shi, Student Member<sup>1</sup>**, Xiaobing Liu, Ph.D., Member<sup>2</sup>, Ming Qu, Ph.D., Associate Member<sup>1</sup> and Bo Shen, Ph.D., Member<sup>2</sup>, (1)Purdue University, West Lafayette, IN, (2)Oak Ridge National Laboratory, Oak Ridge, TN

3:15 PM - 4:45 PM

#### Seminar 15 (Basic)

### Update on the Progress of the Task Force on Building Decarbonization

*Track: Building Decarbonization*

*Room: Augustus III/IV*

**Sponsor: Task Force on Building Decarbonization**

*Chair: Martin Weiland, P.E., Member, US General Services Administration, Washington, DC*

Provide a progress update on the work of this very important task force. Fit into the theme for this conference

#### 1. Update Session I

**Don Colliver, Ph.D., P.E., Presidential Fellow Life Member, University of Kentucky, Lexington, KY**

#### Update Session II

**Thomas Phoenix, P.E., BEMP, Presidential Fellow ASHRAE, Mechanical Contractors, Inc, Charlotte, NC**

## Monday, January 31

Monday, January 31, 8:00 AM - 9:30 AM

### Paper Session 8

### Performance Evaluation of Latest HVAC Systems

*Track: HVAC&R Systems and Equipment*



*Room: Milano V-VII*

*Chair: Suzanne LeViseur, Haddad Engineering, Inc., Jacksonville, FL*

This session reviews different approaches to hybrid heating with TDHPs in multifamily buildings, analyzes the seasonal performance and relative cost savings of GHP VRF systems paired with dedicated outdoor air system and highlights outstanding issues with the advanced fuel-fired technologies testing standard (ANSI Z21.40.4/CGA-2.94). A comparison of steady-state and load-based approaches performed for seasonal performance estimation of a heat pump in heating mode is also reviewed.

#### 1. Hybrid Heating and Hot Water in Multifamily Buildings: Demonstration and Analysis of Integrated Boilers and Thermally-Driven Heat Pumps (LV-22-C022)

**Paul Glanville, P.E., Member<sup>1</sup>**, Michael Mensinger Jr.<sup>1</sup>, Matt Blaylock, Associate Member<sup>2</sup>, Tao Li, Associate Member<sup>3</sup> and Ryan Hardesty, Associate Member<sup>3</sup>, (1)GTI, Chicago, IL, (2)SMTI, Johnson City, TN, (3)Weil McLain, Burr Ridge, IL

#### 2. Gas Engine Heat Pump VRF Modeling Comparison Study with Cold Climate Electric VRF and VAV System (LV-22-C023)

**Ramanathan Dharmarajan, Associate Member, Aleksandr Fridlyand, Ph.D., Member and Patricia Rowley, Associate Member, Gas Technology Institute, Des Plaines, IL**

#### 3. A Review and an Evaluation of the Updated Method of Test for Rating Fuel-Fired Heat Pumps in HVAC (LV-22-C024)

**Aleksandr Fridlyand, Ph.D., Member, Paul Glanville, P.E., Associate Member and Navin Kumar, Ph.D., Gas Technology Institute, Des Plaines, IL**

#### 4. Comparison of Residential Heat Pump Heating Seasonal Performance Based on Load-Based and Steady-State Testing Methodologies (LV-22-C025)

**Parveen Dhillon, Student Member, Travis Horton, Ph.D., Member and James Braun, Ph.D., Fellow ASHRAE, Purdue University, West Lafayette, IN**

8:00 AM - 9:30 AM

**Paper Session 9**

**Two Sides of a Coin: Addressing AC Energy Costs**

*Track: Energy System Integration*



*Room: Milano I-III*

*Chair: David Eldridge Jr., P.E., Member, Grumman/Butkus Associates, Evanston, IL*

Urbanization and rising living standards are increasing the demand for AC, already accounting for a third of global energy. The papers in this session address the increase from two different perspectives. The presenters investigate efficient uses of energy by prototyping a thermoelectric envelope to harvest waste heat into electricity and advancing the modeling of rotary thermal wheels for better optimization. Case studies of natural gas emergency power supply systems (EPSS) with demand-side management operation comparing the economic benefits to both conventional diesel and natural gas emergency-only EPS is reviewed. A comparison of a gas-fired furnace system with cooling and a combined heat and power system in a residential case study is also reviewed during the session.

**1. Comparing Combined Heat and Power with Conventional Forced Air/Grid in Residential Buildings (LV-22-C026)**

*Danielle Caron, Student Member and Ryan Milcarek, Ph.D., Member, Arizona State University, Tempe, AZ*

**2. Natural Gas Generators for Standby Power and Demand-Side Management for More Cost-Effective Energy Resilience (LV-22-C027)**

*Patricia Rowley, Alex Lovallo and Jason Stein, GTI, Des Plaines, IL*

8:00 AM - 9:30 AM

**Paper Session 13**

**Simulations and Control Algorithms for Reducing Energy Consumption**

*Track: Buildings at 360°*



*Room: Augustus V/VI*

*Chair: Raul Simonetti, Member, Carel Industries SpA, Brugine, Italy*

The variability of climatic conditions, occupancy patterns and behavior constitute a challenge when designing building systems and assemblies (e.g., HVAC, services, etc.), or when doing existing building commissioning (EBCx). Modelling and simulations can help address this challenging variability. The papers in this session span across a pre- & post-EBCx comparison, natural ventilation modelling to save energy, configuration and control for dual VAV systems.

**Autonomous Buildings Enable Energy Efficiency (LV-22-C028)**

*Troy Harvey, Member, PassiveLogic, Salt Lake City, UT*

**1. The Impact of Existing Building Commissioning on Electric Peak Demand (LV-22-001)**

*Ahmed Morsy, Student Member, Texas A&M University, College Station, TX*

**2. Assessing the Impacts of Natural Ventilation on Building Energy Use: A Case Study of a Mid-rise Residential Building in Chicago, IL (LV-22-002)**

*Insung Kang, Illinois Institute of Technology, Chicago, IL*

**3. New Configuration and Control for Dual VAV Systems to Achieve Better Building Energy Efficiency (LV-22-003)**

*Nabil Nassif, Ph.D., P.E., Member, University of Cincinnati, Cincinnati, OH*

8:00 AM - 9:30 AM

**Seminar 16 (Intermediate)**

**Electric Grid to Building Interface and Decarbonization through Sequestration**

*Track: Building Decarbonization*



*Room: Neopolitan III/IV*

**Sponsor: Task Force on Building Decarbonization**

*Chair: Martin Weiland, P.E., Member, US General Services Administration, Washington, DC*

When a building is operational, it has a choice of both how to manage its electricity usage and where to obtain that electricity. The electricity can be site generated, obtained from on-site energy storage and obtained from the electric grid. In order to advance reductions in carbon, the building needs to have the ability to make both a carbon and a value judgement in

these decisions. The amount of carbon in a central electric grid changes on a minute-by-minute basis, as does the cost to provide that electricity. How does decarbonization through sequestration work in building design?

**1. How Do Buildings Play a Role in Decarbonizing the Grid and How Does the Grid Talk Back?**

*Katherine Hammack, USGBC, Washington DC, DC*

**2. Decarbonization through Sequestration**

*Lance Davis, AIA, US Federal Agency, Washington, DC*

8:00 AM - 9:30 AM

**Seminar 17 (Intermediate)**

**Energy System Integration a.k.a. Combined Heat and Power**

*Track: Energy System Integration*



*Room: Neopolitan I/II*

**Sponsor: 1.10 Cogeneration Systems**

*Chair: Blake Ellis, P.E., Fellow ASHRAE, Burns & McDonnell, Overland Park, KS*

Combined Heat and Power (CHP) defines energy system integration, as the waste heat of power generation is recycled for building thermal needs. While some are focused on electrification of all building loads, CHP can provide a practical pathway towards decarbonization through energy system integration and provides the most efficient use of fuel, whether fossil, bio, hydrogen or other. This seminar explores how CHP supports the development of the renewable energy grid, compares electrification to CHP and provides a glimpse of the future with non-carbon CHP that provides dispatchable energy which is vital to a stable grid.

**1. Energy System Integration with Loads and the Grid through CHP**

*Gearoid Foley, Member, Integrated CHP Systems Corp., Princeton, NJ*

**2. ESI Vs. ESI**

*Blake Ellis, P.E., Fellow ASHRAE<sup>1</sup> and Praveen Cheekatamarla, Ph.D., Member<sup>2</sup>, (1)Burns & McDonnell, Overland Park, KS, (2)Oak Ridge National Laboratory, Oak Ridge, TN*

**3. Energy Systems Integration with H2 CHP**

*Richard Sweetser, Life Member, Exergy Partners Corp., Herndon, VA*

8:00 AM - 9:30 AM

**Seminar 18 (Intermediate)**

**Lubricants for New Low GWP Refrigerant Candidates**

*Track: Refrigerants and Refrigeration*

*Room: Augustus III/IV*

**Sponsor: 3.4 Lubrication**

*Chair: Greg Smith, Ph.D., Associate Member, Honeywell International, Buffalo, NY*

The HVAC/R industry continues to develop new refrigerants to meet low global warming potential regulations, and this can lead to challenges for lubrication. The seminars in this session provide insight into how refrigerant and lubricant chemical stability, miscibility and physical performance metrics are evaluated and applied to determine if new lubricants are required when refrigerants change, and if so, how new lubricants are developed to meet the needs of the industry.

**1. Lubricants for Low GWP Refrigerants: From Concept to Compressor Operation**

*Joseph Karnaz, Member, Shrieve Chemical Products, Inc, The Woodlands, TX*

**2. Investigation of Lubricant Effects on Low GWP Refrigerant Performance**

*Ramesh Navaratnam, Member, Patech Fine Chemicals Co. Ltd., Dublin, OH*

**3. Dealing with Highly Soluble Low GWP Refrigerants**

*Joseph Karnaz, Member, Shrieve Chemical Products, Inc, The Woodlands, TX*

Monday, January 31, 9:45 AM - 10:45 AM

**Paper Session 11**

**Research Advancements in Air Side Equipment and Components**

*Track: HVAC&R Systems and Equipment*



*Room: Milano V-VII*

Chair: Davide Ziviani, Ph.D., Member, Center for High Performance Buildings, Purdue University, West Lafayette, IN

In this session, the first paper covers how a backward centrifugal fans performance is impacted by suction chamber intrusions and the proximity of the housing wall to the fan discharge by using CFD analysis; the second paper evaluates the level of insulation required to prevent condensation on the duct surface from the air surrounding the duct by developing a coupled heat transfer model; the third paper explains the field studies to test the ASHRAE Guideline 36 duct static resetting algorithm, measures its performance under various conditions in fully instrumented VAV systems located in the HVAC lab at the University of Cincinnati, and proposes improvements to the guideline.

**1. Studying the Effects of Suction Chamber Intrusions and Housing Proximity on Backward Centrifugal Fan Performance Utilizing Computational Fluid Dynamics (LV-22-C031)**

*Adam Michalson, Kevin L. Amende, P.E., Associate Member and Erick Johnson, Montana State University, Bozeman, MT*

**2. Analysis of Condensation on Ducts of Various Insulation Levels Using Coupled Heat-Mass Model with Building Simulation Data for California Climate Zones (LV-22-C032)**

*Antash Najib, Ph.D., Member<sup>1</sup>, Mark Modera, Ph.D., P.E., Fellow ASHRAE<sup>2</sup> and Frederick Meyers<sup>2</sup>, (1)Pakistan Navy Engineering College (NUST), Karachi, Pakistan, (2)University of California, Davis, CA*

**3. Field and Simulation Testing and Improvement of ASHRAE Guideline 36 Duct Static Pressure Resetting Algorithm (LV-22-C033)**

*Nabil Nassif, Ph.D., P.E., Member, University of Cincinnati, Cincinnati, OH*

**4. Energy Modeling of Variable Air Volume Parallel Fan Powered Terminal Units Using Energyplus**

*Zahra Sardoueinassab, Member<sup>1</sup>, Peng Yin, Ph.D., Associate Member<sup>2</sup> and Dennis O'Neal, Ph.D., Fellow ASHRAE<sup>3</sup>, (1)Nailor Industries, Houston, TX, (2)University of Louisiana at Lafayette, Lafayette, LA, (3)Baylor University, Waco, TX*

9:45 AM - 10:45 AM

**Seminar 19 (Basic)**

**ASHRAE Conference Crash Course**

*Track: Fundamentals and Applications*

*Room: Augustus V/VI*

**Sponsor: YEA Committee**

*Chair: Madison Schultz, P.E., Member, OK BeCo, Oklahoma City, OK*

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

**1. The Ins and Outs of ASHRAE**

*Elise Kiland, P.E., Member, Critchfield Mechanical, Inc, San Jose, CA*

**2. Make the Most of Your Conference Experience**

*Zachary Alderman, P.E., Member, DLZ Corporation, South Bend, IN*

9:45 AM - 10:45 AM

**Seminar 20 (Intermediate)**

**HVAC Design, Control and Operation of Hospitals After COVID-19 Fiasco**

*Track: Environmental Health and IEQ in the International Arena*



*Room: Augustus III/IV*

**Sponsor: 1.4 Control Theory and Application, 9.6 Healthcare Facilities , TC-1.5, TC-7.3, TC-7.5, TC-2.8**

*Chair: Frank Shadpour, P.E., Fellow ASHRAE, SC Engineers, Inc., San Diego, CA*

COVID-19 came from nowhere; worldwide and without exception, our hospitals were not ready. Healthcare planners didn't expect it and HVAC Engineers had not designed for it. So, what happens now? We obviously don't have adequate numbers of isolation rooms and research indicates that the ventilation methods of the past are inadequate to support the infection control and indoor air quality requirements of the future. This seminar presents the latest technology and findings for the proper design, control and operation of hospitals to comply with today's requirements. Air change per hour, filtration and building automation are among the topics of discussion.

**1. The Hospital of the Future: Designing for Energy Efficiency and Infection Control**

*Timothy Jacoby, Scripps Health, San Diego, CA*

**2. Designing Flexible and Adaptable HVAC Systems**

*Renshaw Edward, P.E., Kaiser Permanente, La Mesa, CA*

9:45 AM - 10:45 AM

**Forum 2**

**Diversity, Equity, Inclusion and ASHRAE: Does It Really Matter?**

*Track: Fundamentals and Applications*

*Room: Neopolitan III/IV*

**Sponsor: Board of Directors DEI Advisory Subcommittee**

*Chair: Adrienne Thomle, Retired, Reno, NV*

In 2020, ASHRAE established a Proactive Diversity Task Group to recommend programs and initiatives seeking to eliminate all forms of discrimination and social injustice, and proactively drive diversity through all levels within ASHRAE. Some members ask “why?” As an engineering society, shouldn’t ASHRAE be focusing its efforts and that of its volunteers on research and education? What role, if any, should ASHRAE play in diversity in the AEC community and social justice? Is there really a problem that needs to be solved? We want to hear from you: the members. This forum intends to tackle these questions head on.

9:45 AM - 10:45 AM

**Workshop 2 (Intermediate)**

**Benefits and Cost Justification of Cloud-Based Building Energy Analytics**

*Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities*



*Room: Milano I-III*

*Chair: Bert G. Phillips, P.Eng., MBA, UNIES Ltd., Winnipeg, MB, Canada*

NYSERDA's real time energy management program incentivized over 600 cloud-based energy analytics deployments in New York state, in commercial and multifamily buildings with systems from over 40 providers. This presentation delivers a cross-cutting of cost-benefits analysis of energy analytics platforms spanning various construction vintages, mechanical systems, building end-uses, occupancy patterns and technology providers. The installed costs range from fractions of a dollar to over ten dollars per square foot. Regardless, benefits almost always justified total costs while improving the health and comfort of the building environments.

**1. Benefits and Cost Justification of Cloud-Based Building Energy Analytics**

*Pavan Kumar Ryali, NYSERDA, New York, NY*

Monday, January 31, 11:00 AM - 12:00 PM

**Paper Session 12**

**Modelling Materials and Devices to Use Them at Best**

*Track: HVAC&R Systems and Equipment*



*Room: Augustus V/VI*

*Chair: Maggie Moninski, P.E., SINGH + Associates Inc., Chicago, IL*

Knowing the properties of materials and devices is an essential prerequisite for exploiting their characteristics at both the design and deployment phase. The papers in this session cover this important topic spanning from wall assemblies, to HVAC mixing boxes, and, finally, to phase change materials.

**1. Development of a U-factor Calculation Procedure for Cold-Formed Steel C-shape Clear Wall Assemblies (LV-22-004)**

*Merle McBride, Ph.D., P.E., Life Member, Consulting Engineer, Granville, OH*

**2. The Use of CFD to Understand Mixing, Controls, and Dampers in Air Handling Units (LV-22-005)**

*Donald Willoughby, P.E., Member, ASHRAE, Atlanta, GA*

11:00 AM - 12:00 PM

**Seminar 3 (Intermediate)**

**Would Your Building Perform Satisfactorily During a Heatwave or Power-Blackout?**

*Track: Buildings at 360°*



*Room: Neopolitan I/II*

**Sponsor: 4.2 Climatic Information, 2.8 Building Environmental Impacts and Sustainability**

*Chair: Joe Huang, Member, White Box Technologies, Inc., Moraga, CA*

Residents in lower-income neighborhoods typically have less access to green spaces and shading trees, increasing extreme heat exposure. Electricity can fail during heatwaves, especially if air-conditioning installations have outpaced the capacity of power grids. The sufficiency of passive and low energy alternatives depend on the extreme coincidence of heat and humidity. This seminar suggests how you might adapt your design solutions to three challenges for any particular project. Is air-conditioning necessary to satisfy the needs of building occupants? Could passive features maintain satisfactory performance during heatwave/power-blackout events? What are the social and environmental justice implications of air-conditioning your client's project?

**1. Strategies for Urban Cooling – How Buildings Can Improve Indoor and Outdoor Urban Climates**

*David Sailor, Ph.D., P.E., Arizona State University, Tempe, AZ*

**2. Could a Passive Design Satisfy the Needs of Building Occupants?**

*Eric Peterson, Ph.D., P.E., Member, University of Leeds, Leeds, United Kingdom*

11:00 AM - 12:00 PM

**Seminar 21 (Intermediate)**

**Does it Matter Where your Weather Data Comes From?**

*Track: Buildings at 360°*



*Room: Milano V-VII*

**Sponsor: 4.2 Climatic Information, 2.5 Global Climate Change**

*Chair: Parag Rastogi, Ph.D., Member, arbnco ltd, Glasgow, United Kingdom*

Weather is a critical input to building design and analysis. Novel weather data sources like global climate models, hyperlocal modelling, and crowd-sourced weather data currently coexist with outdated “weather files” from conventional airport stations. This seminar will discuss neglected but important questions about how climate zones are defined and selected. The speakers will also share their experience with creating weather files from raw data to obtain the weather data published in Ch. 14 (Climatic Information) of the Handbook – Fundamentals, Std. 169, and the IWEC files, as well as new technologies improving data quality and availability.

**1. How the Sausage Is Made: Past, Present and Future Adventures in Determining Climate Zones**

*Drury Crawley, Ph.D., BEMP, Fellow ASHRAE, Bentley Systems, Inc., Washington, DC*

**2. Adventures in Wrangling Weather Data for Building Design and Analysis**

*Drury Crawley, Ph.D., BEMP, Fellow ASHRAE, Bentley Systems, Inc., Washington, DC*

**3. The ASHRAE IWEC2 Files Are Decades Old: Are They Still Useful in a Changing Climate?**

*Yu Joe Huang, BEMP, Fellow ASHRAE, White Box Technologies, Moraga, CA*

11:00 AM - 12:00 PM

**Seminar 23 (Advanced)**

**Integrated Smart Heating and Cooling Systems**

*Track: Energy System Integration*



*Room: Augustus III/IV*

**Sponsor: 6.8 Geothermal Heat Pump and Energy Recovery Applications**

*Chair: Graeme Maidment, Ph.D., P.E., London South Bank University, London, United Kingdom*

Heating and cooling can be controlled individually or can form part of a smart heating and cooling network. By integrating into a low temperature heat networks, it's possible to deliver further carbon savings, since heat can be shared between heating and cooling applications and captured from secondary sources. The principles of integrated smart heating and cooling energy systems are well described, lessons learned may not because their deployment is relatively new. This seminar brings together knowledge and understanding of these smart networks by presenting and discussing examples with different levels of complexity and application.

**1. Feeding R&D Back into Government Policy**

*Joel Hamilton, UK Government, London, United Kingdom*

**2. The Need for Smart Local Energy Systems**

*Graeme Maidment, Ph.D., P.E., London South Bank University, London, United Kingdom*

**3. Green Smart Community Integrated Energy Systems**

*Akos Revesz, Ph.D., Affiliate, London South Bank University, London, United Kingdom*

**4. Low Temperature Heat Networks in Sweden**

*Helen Carlström, E.On, Malmo, Sweden*

Monday, January 31, 2:15 PM - 3:15 PM

**On-Demand Paper Session (Intermediate)**

**Live Q&A Session 2: BEM and Hygiene-Related HVAC Design**

*Chair: Ahmed Abdelsalam, Amazon, Dublin*

**1. Macro-Level Changes and the Influence on the Danish Building Industry (LV-22-C061)**

*Nanna B. Overgård and Amalie Palme, Technical University of Denmark, Kongens Lyngby, Denmark*

**2. Standard Environmental Aerosol Risk of Common HVAC Options in Dentistry (LV-22-C062)**

*Travis R. English, P.E., Member, Kaiser Permanente, Oakland, CA*

**3. Five Years Later: A Building Energy Modeling Fleet's Second Round Institutional Energy Retrofit Analysis (LV-22-C063)**

*Daniel Villa, P.E., Member<sup>1</sup>, Mark Adams<sup>2</sup>, Gerald Gallegos, P.E.<sup>3</sup> and Aaron Garrett, Ph.D.<sup>2</sup>, (1)Sandia National Laboratories, Alamo (virtual employee), TX, (2)Tunation, LLC, Knoxville, TN, (3)Sandia National Laboratories, Albuquerque, NM*

**4. Hygienic Design of HVAC Systems for Hospitals (LV-22-C065)**

*Faisal Ahmed, Affiliate and William R. Shultes, Upstate Parts and Supply, Inc, Syracuse, NY*

2:15 PM - 3:45 PM

**Seminar 25 (Intermediate)**

**Seismic Certification of Equipment**

*Track: Fundamentals and Applications*



*Room: Augustus III/IV*

**Sponsor: 2.7 Seismic and Wind Resistant Design**

*Chair: Matthew Hooti, P.E., Member, ISOTECH Industries inc, Woodbridge, ON, Canada*

Join this session to gain a clear understanding of the requirements, benefits and ease of going through the process of certifying equipment to the ASCE7. Presenters in this session provide greater understanding of code requirements for seismic certification of equipment. When is it required, where is it required and what are acceptable methods and standards?

**1. Code Requirements: When/Where**

*Robert Simmons, P.E., Member, Petra Seismic Design, Houston, TX*

**2. Equipment Manufacturing Experience**

*Harold Dubensky, P.E., Member, Johnson Controls, Inc., York, PA*

**3. How: Certification Requirements**

*John Giuliano, P.E., Member, Vibration Mountings & Controls, Bloomingdale, NJ*

**Tuesday, February 1**

Tuesday, February 1, 8:00 AM - 9:30 AM

**Panel 1 (Intermediate)**

**In Real Time: Charting the Pathway for Existing Buildings to Get to Carbon Neutrality**

*Track: Buildings at 360°*

*Room: Milano I-III*

**Sponsor: 2.8 Building Environmental Impacts and Sustainability**

*Chair: Paul Torcellini, Ph.D., P.E., Fellow ASHRAE, National Renewable Energy Laboratory, Golden, CO*

Many corporate entities have set goals to be carbon neutral by a specific date, often within the next 20 years. This shift will take a concerted effort by these owners to make substantial changes to their buildings. But who makes the plan? Design firms are being asked more and more to provide planning and strategies to shift carbon consumption within the business cases for owners. This interactive panel in real-time will debate and create an action plan to bring a building to carbon neutrality. The audience will have a chance to brainstorm, comment and help drive the action plan development.

**1. Creating an Effective Action Plan #1**

*Stet Sanborn, AIA, Member, Smith Group, San Francisco, CA*

**2. Creating an Effective Action Plan #2**

*Kent Peterson, P.E., Presidential Fellow ASHRAE, P2S, Inc., Long Beach, CA*

**3. Creating an Effective Action Plan #3**

*John Hickey, P.E., Jacobs, Seattle, WA*

**4. Creating an Effective Action Plan #4**

*Kiersten Washle, Associate Member, CMTA, Boston, MA*

8:00 AM - 9:30 AM

**Paper Session 14**

**Characterizing Device Performances by Field Tests and Measurements**

*Track: HVAC&R Systems and Equipment*



*Room: Milano V-VII*

*Chair: Davide Ziviani, Ph.D., Member, Center for High Performance Buildings, Purdue University, West Lafayette, IN*

The quest for increasing the energy efficiency of equipment and buildings, both at individual and at district level, requires the estimation/assumption of device characteristics and the assessment of what the real performance is. This session deals with measuring the performances of the following devices by experiment or by real-time measurement in the field including adsorption-based desiccant material, AC for a data center, hybrid boiler array and residential AC systems.

**1. Demonstration of Hybrid Boiler Arrays to Improve Heating Season Efficiency, Provide Redundancy, and Minimize Capital Investment (LV-22-C035)**

*Abinash Ravi, Associate Member<sup>1</sup>, Kris Jorgensen, Ph.D., Associate Member<sup>2</sup>, Douglas Kosar, Member<sup>2</sup>, Alex Lavollo<sup>2</sup> and Patricia Rowley, Associate Member<sup>2</sup>, (1)Gas Technology Institute, Des Plaines, IL, (2)GTI, Des Plaines, IL*

**2. Experimental Characterization of Adsorption Isotherm of Solid Desiccant Materials for Use in Air Dehumidification Devices (LV-22-C036)**

*Tomas Venegas, BEMP, Associate Member<sup>1</sup>, Ming Qu, Ph.D., Associate Member<sup>1</sup>, Kashif Nawaz, Ph.D., Member<sup>2</sup> and Lingshi Wang<sup>2</sup>, (1)Purdue University, West Lafayette, IN, (2)Oak Ridge National Laboratory, Oak Ridge, TN*

**3. Repeatability Assessment of Load-Based Testing Methodology for Residential Air Conditioning Equipment (LV-22-C037)**

*Parveen Dhillon, Student Member, Dohyeon Kim, Travis Horton, Ph.D., Member and James Braun, Ph.D., Fellow ASHRAE, Purdue University, West Lafayette, IN*

8:00 AM - 9:30 AM

**Paper Session 15**

**Light and Shade**

*Track: Buildings at 360°*



*Room: Augustus V/VI*

*Chair: Nohad Boudani, PEng, Member, Sodicom, Beirut, Lebanon*

Controlling the lighting in a room has consequence on the indoor environmental quality. This session investigates the use of lights and shades by proposing an intelligent control of a venetian blind that automatically adjusts the solar irradiation reaching the room by tilting the slat angle; it also proposes a study about adjusting the internal light by using a fully-integrated lighting control system which dynamically controls the fixture dimming level; finally, co-modeling the shading devices and the fenestrations using energy and irradiation simulation software which can predict the optimal settings.

**1. More Light, Less Energy: Validating Fully-Integrated LED Controls for DoD Interior Lighting Applications (LV-22-C038)**

*Bryan Urban, Fraunhofer USA, Boston, MA*

8:00 AM - 9:30 AM

**Seminar 26 (Intermediate)**

**Advanced Heat Exchanger Simulation and Optimization Tools for HVAC Applications**

*Track: HVAC&R Systems and Equipment*





Room: Neopolitan I/II

**Sponsor: 1.13 Optimization**

Chair: Khaled Saleh, Ph.D., P.E., Member, Goodman Manufacturing, Daikin Group, Houston, TX

In this session, there will be three presentations by National Institute of Standards and Technology, University of Maryland and Oak Ridge National Lab to introduce the state-of-the-art simulation and optimization tools for air-cooled heat exchangers for HVAC Application. All the tools can be used for designing and optimizing the heat exchangers for the current refrigerants and low GWP refrigerants. Practical examples from industry are presented along with the description of the optimization algorithms used in simulation and optimization tools.

**1. Optimization of Heat Exchangers Using Steady State Simulation Tools Coupled with CFD and Multiobjective Genetic Algorithms**

Vikrant Aute, Ph.D., Member, University of Maryland, College Park, MD

**2. Evap-Cond Simulation Tool with Optimization Refrigerant Circuitry**

Piotr Domanski, Ph.D., Fellow ASHRAE, National Institute of Standards and Technology, Gaithersburg, MD

**3. Optimization and Lccp Evaluation of a Residential Heat Pump Using 5-Mm Tubes and Refrigerants with GWP <150**

Zhenning Li, Ph.D., Associate Member, Oak Ridge National Laboratory, Oak Ridge, TN

8:00 AM - 9:30 AM

**Seminar 27 (Advanced)**

**Impact of Workplace Furnishing System and Air Distribution on Infectious Diseases**

Track: Environmental Health and IEQ in the International Arena



Room: Neopolitan III/IV

Chair: Julia Murphy, SOM, New York City, NY

Will the workplace layout be changed after pandemics? While there are Wells Riley tools to understand overall risk in offices, the layout of furnishing systems interaction with people and air flow are less understood. In this seminar, a conceptual framework of diseases spread in the workplace is provided. A furnishing system provider will identify different conventional and possible post pandemic furnishing set ups to understand the risk of infection with air flow interaction impacts. Both Wells Riley and computational fluid dynamics tools will be used to evaluate the risk.

**1. Framework of Infectious Disease Spread in the Workplace**

L. Bourouiba, Ph.D., MIT, Cambridge, MA

**2. The Effect of Workplace Furnishing Layouts on Air Flow and Disease Transmission**

Sharon Tracy, Ph.D., Steelcase, Grand Rapids, MI

**3. ASHRAE ETF Office Guide: Consideration of Air Flow and Furnishing Systems**

Luke Leung, P.E., BEMP, Member, Skidmore, Owings, & Merrill LPP, Chicago, IL

**4. Utilizing CFD to Study Different Post Pandemic Workplace Layouts**

Stephen Ray, Ph.D., P.E., Associate Member and Kristina Lundeen, North Park University, Chicago, IL

8:00 AM - 9:30 AM

**Seminar 28 (Intermediate)**

**Understanding and Applying Gas-Fired Low Intensity Infrared Radiant Heat Systems in Industrial Facilities**

Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities



Room: Augustus III/IV

**Sponsor: 6.5 Radiant Heating and Cooling**

Chair: Ongun Berk Kazanci, Ph.D., Associate Member, International Centre for Indoor Environment and Energy, Technical University of Denmark, Kgs. Lyngby, Denmark

This session is a continuation of information on gas-fired low intensity infrared heat presented at the virtual summer meeting in June. This session strives to present an overall awareness of the benefits of gas-fired low intensity infrared heat when applied to industrial and commercial buildings. Practitioners must understand that its physical properties differ from air based heat systems. The presentations exemplify the basic physical properties of infrared heating, energy efficiency and its high level of comfort when applied correctly. Presenters will cover basic theory and applications in distribution and industrial facilities.

**1. Intermediate Understanding of Infrared Radiant Heating**

*Kevin Mahoney, Specified Air, Comstock Park, MI*

**2. Gas-Fired Infrared Heat for Distribution and Fulfillment Centers**

*Donald E. Larsson, Member, Specified Air Solutions, Buffalo, NY*

**3. Gas Fired Infrared Heating from a Consulting Engineer's Perspective**

*Gregory Topp, P.E., Roger D Fields Associates, Columbus, OH*

**4. Gas Fired Infrared Heating from an Owner's Perspective**

*Firyal Kassim, Federal Express Ground, Moon Township, PA*

Tuesday, February 1, 9:45 AM - 10:45 AM

**Paper Session 16**

**Virtual:How the Use of Smart "Self-Learning" Controls Can Enhance the Building Efficiency**

*Track: Buildings at 360°*



*Chair: Brian M. Fronk, Ph.D., P.E., Associate Member, Oregon State University, Corvallis, OR*

In the last decade the use of controls that can predict occupancy inside buildings or interacts with the rate of occupancy has evolved tremendously in the vision to have more energy efficient buildings and enhance comfort. However, controls can fail and send the wrong message to the equipment. The need of new control approaches is crucial to make buildings smarter by measuring not only the direct presence of occupants, but also to predict the historical occupancy density based on factors such as dynamic schedules, environmental records and people behavior. This session presents different approaches toward smarter controls.

**1. A Data-Driven Method to Test and Fine-Tune Occupant-Centric Building Controls Prior to Implementation (LV-22-C040)**

*Hamidreza Karimian<sup>1</sup>, Mohamed Ouf, Associate Member<sup>2</sup>, Nunzio Cotrufo, Student Member<sup>3</sup> and Jean-Simon Venne<sup>4</sup>,*

*(1)Concordia university, Montreal, QC, Canada, (2)Concordia University, Montreal, QC, Canada, (3)Department of Building, Civil and Environmental Engineering, Concordia University, Montreal, QC, Canada, (4)BrainBox AI, Montreal, QC, Canada*

**2. Towards Post-Pandemic City Management: Prediction of Occupancy Profiles of Commercial Buildings in New York City (LV-22-C041)**

*Aya Doma, Student Member<sup>1</sup>, Ahmed Zaalouk<sup>1</sup>, Hamidreza Karimian<sup>2</sup>, Mohamed Osman<sup>3</sup>, Mazdak Nik-Bakht<sup>4</sup> and Mohamed Ouf, Associate Member<sup>4</sup>, (1)Concordia University, Montréal, QC, Canada, (2)Concordia university, Montreal, QC, Canada, (3)Concordia University, Montréal, QC, Canada, (4)Concordia University, Montreal, QC, Canada*

**3. Experimental Design and Analysis of Reliability Evaluation of Off-the-Shelf Occupancy Sensor System in Residential Buildings (LV-22-C042)**

*Yiyi Chu, Debrudra Mitra, Kristen Cetin, Ph.D., P.E., Member and Sam Evans, Michigan State University, East Lansing, MI*

**4. Preliminary Investigation of Active Demand Flexibility Control at Ahus Using Energy Feedback Control (LV-22-C010)**

*Rodney D. Hurt, Student Member<sup>1</sup>, Zufen Wang, Student Member<sup>2</sup>, Gang Wang, P.E., Member<sup>3</sup>, Esber Andiroglu<sup>3</sup> and Li Song, Ph.D., P.E., Member<sup>1</sup>, (1)University of Oklahoma, Norman, OK, (2)University of Miami, Miami, FL, (3)University of Miami, Coral Gables, FL*

9:45 AM - 10:45 AM

**Paper Session 17**

**Water-Energy Nexus Both in Central and District Systems**

*Track: HVAC&R Systems and Equipment*

*Room: Augustus III/IV*

*Chair: Jeremy Caron, City of Des Moines, Des Moines, IA*

This session discusses the water-energy nexus. Water, not only energy, is one of the most importance resources that needs preserving. The concept of energy saving can be expanded to water saving, and to resource saving. Water and energy usage are strictly related in systems that focus on saving the energy while minimizing water. They range from central systems to district systems, that need to consider the variability of climatic conditions to deliver the required heating and cooling. The concept of saving energy, water, etc., however, cannot be disentangled from that of resilience, because systems are required to recover their duties after a disruption.

**1. Waterside Economizer Control in ASHRAE RP-1711 (LV-22-007)**

*Steven Taylor<sup>1</sup> and Brandon Gill, P.E., Member<sup>2</sup>, (1)Taylor Engineering LLC, Alameda, CA, (2)Taylor Engineers, Alameda, CA*

**2. Installation Energy and Water Resilience Planning (LV-22-008)**

*William James Wolfe and Jill Schueckler, US Army Corps of Engineers, Champaign, IL*

### 3. Reducing Cost of Chilled Water Thermal Storage Systems to Encourage Adoption of Energy Efficient Thermal Plants (LV-22-C030)

*Jacob Miller, Member, M2 Thermal Solutions LLC, Somerville, MA*

9:45 AM - 10:45 AM

#### Forum 3

### Should Have Seen That Coming! Climate Impacts on Cleanrooms, Labs, Hospitals and other Critical Environment Operations

*Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities*

*Room: Neopolitan III/IV*

**Sponsor: 9.11 Clean Spaces, 1823 , TC 1.7; TC 9.02; TC 9.09; TC 9.10**

*Chair: Mitchell Swann, P.E., Resolution Management Consultants, Marlton, NJ*

Blistering heat waves, droughts, monsoon-esque floods, massive power outages and municipal water system shutdowns – all of these stablemates of the apocalypse have come to visit in recent years. Are massive forest fires really a ‘surprise’ out west anymore? Swings in climatic conditions have gotten more extreme and more widely dispersed across the globe. These extremes can wreak havoc on operations with critical environmental control needs or high resource demands. This forum looks at the role and limits of design in dealing with these infrequent but impactful events on design and operating decisions and on business interruption insurance policies.

Tuesday, February 1, 11:00 AM - 12:30 PM

#### AHR Expo Session 1 (Intermediate)

### The Industry Transition to A2L Refrigerants: Where Are We and Where Are We Headed?

*Track: Refrigerants and Refrigeration*

*Room: N235/N237*

**Sponsor: 7.3 Operation and Maintenance Management**

*Chair: Matthew Mullen, P.E., Member, EMCOR Services New England Mechanical, South Windsor, CT*

U.S. Regulations are requiring the industry to transition to low Global Warming Potential (GWP) refrigerants as early as 2025 due to the recently passed *American Innovation and Manufacturing Act*. Many proposed lower GWP refrigerants are classified as slightly flammable ASHRAE Class 2L refrigerants which will require changes in how our industry works. This seminar explains the regulatory landscape, some of the key industry research done by AHRI and ASHRAE, changes in critical industry standards (including ASHRAE 15), changes in service practices and codes that will be necessary for the transition to the lower GWP ASHRAE class 2L refrigerants.

#### 1. U.S. and Worldwide Regulatory Drivers for Transitioning to Low GWP Refrigerants

*Helen Walter-Terroni, Air Conditioning, Heating and Refrigeration Institute, Arlington, VA*

#### 2. Understanding the Risks: Research Results on A2L Refrigerant Safety

*Dick Lord, Carrier, Monteagle, TN*

#### 3. The Standard and Code Impacts of A2L Refrigerants

*Mary Koban, Air Conditioning, Heating and Refrigeration Institute, Arlington, VA*

#### 4. Servicing Equipment with A2L Refrigerants: What Technicians Will Need Know

*Jason Obrzut, ESCO Group, Mt. Prospect, IL*

#### 5. Spray Evaporation on an Enhanced Surface Tube Bundle with Low GWP Refrigerant HFO-1234ze(E)

*Joshua Rothe, Student Member, Auburn University, Auburn, AL*

11:00 AM - 12:30 PM

#### Paper Session 18

### Addressing IEQ Challenges Through CFD Simulations, Air Cleaning Technologies and Advanced Particle Removal Technology

*Track: Environmental Health and IEQ in the International Arena*



*Room: Augustus V/VI*

*Chair: Christine Reinders-Caron, Member, Iowa State University, Omaha, IA*

The SARS-CoV-2 pandemic has created new IEQ challenges. The papers in this session present CFD analysis to determine the efficacy of UVGI systems and provide valuable insights to practicing and design engineers related to the design and operation of UVGI systems; challenges encountered in the evaluation of air-cleaning technologies; a new form of electrostatic filtration consisting of porous collecting electrodes to collect and hold a large capacity of different particles regardless of their nature of physical properties.

**1. Computational Fluid Dynamics Analysis of Ultraviolet Germicidal to Control the Probability of Infection Due to Transmission of Airborne Pathogens (LV-22-C043)**

*Kishor Khankari, Ph.D., Fellow ASHRAE<sup>1</sup> and William Bahnfleth, Ph.D., P.E., Presidential Fellow ASHRAE<sup>2</sup>, (1)AnSight LLC, Ann Arbor, MI, (2)Penn State, University Park, PA*

**2. Advanced Particle Removal Technology as an Efficient Tool for Addressing Emerging Global Air Quality and Safety Challenges (LV-22-C045)**

*Larry Rothenberg, J.D.<sup>1</sup>, Igor Krichtafovitch, Ph.D.<sup>2</sup>, Alan Viosca<sup>2</sup> and Norm Long, Member<sup>2</sup>, (1)Agentis Air LLC, Rockville, MD, (2)AgentiAir, rockville, MD*

**3. Challenges in Evaluating Air-Cleaning Technologies and Directions for Future Research**

*Christos Polyzois, Ph.D., Member, Independent Consultant, Bloomington, MN*

11:00 AM - 12:30 PM

**Paper Session 19**

**Dehumidification: Materials, Devices, Energy Issues and Water Recovery**

*Track: Fundamentals and Applications*



*Room: Milano V-VII*

*Chair: Gary Debes, Gary Debes Consulting Services, Coatesville, PA*

The water content of air is its humidity. Dehumidification consists in the reduction of the air's water content, and it may occur spontaneously or be forced on purpose. In the latter case, the condensate that builds up affects the heat transfer properties of the device causing dehumidification, not to mention its energy consumption. Authors in this session present the negative effects of frost formation on evaporators and how they can be tackled by superhydrophilic or superhydrophobic coatings. The session investigates the gap effect in mini-channel heat exchangers with condensation and analyzes the energy associated to some dehumidification technologies in cannabis indoor operations.

**1. Investigation of Influence of Superhydrophilic and Superhydrophobic Coated Aluminum Surfaces on Frost Formation (LV-22-C046)**

*Emma Nyholm Humire<sup>1</sup>, Mikael Järn, Ph.D.<sup>2</sup> and Erik Björk, Ph.D.<sup>1</sup>, (1)Royal Institute of Technology (KTH), Stockholm, Sweden, (2)RISE Research Institutes of Sweden, Stockholm, Sweden*

**2. Novel Use of Fertilizer as a Liquid Desiccant for Greenhouse Dehumidification and Water Recovery (LV-22-C047)**

*Jonathan Maisonneuve, Ph.D., Associate Member and Sanchayan Pushparajah, Oakland University, Rochester, MI*

**3. Comparative Energy Analysis of Dehumidification Technologies for Indoor Cannabis Operations (LV-22-C048)**

*Josh Spalding, Associate Member, Quest (Therma-Stor), Los Angeles, CA*

11:00 AM - 12:30 PM

**Seminar 31 (Intermediate)**

**High Efficiency Variable Speed Pumping Systems and Integration Challenges with Chiller Plant Design**

*Track: Buildings at 360°*



*Room: Augustus III/IV*

**Sponsor: 8.2 Centrifugal Machines, 6.1 Hydronic and Steam Equipment and Systems, TC 8.1, TC 2.8**

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

This session overviews variable speed chilled water pumping systems with a technical understanding of how a chiller fits into primary-secondary, variable primary and distributed-variable primary systems. The purpose of this seminar is to present the technical points of each type of pumping system in terms of function and operation while providing an understanding of how a water chiller responds functionally to a variable fluid flow through its evaporator. Presenters provide pointers and suggestions in the form of lessons learned regarding the control and operation of each of these systems.

**1. Key Chiller Selection Criteria in a Variable Flow Pumping System**

*Rick Heiden, Member, Trane, La Crosse, WI*

**2. Pumps That Know the Flow in Chilled Water Pumping Systems**

*David Lee, P.Eng., Member, Armstrong Fluid Technology, Toronto, ON, Canada*

**3. Lessons Learned in Control and Operation of Primary-Secondary and Distributed Pumping Chilled Water Systems**  
*Chris Miller, P.E., Member, P2S, Inc., Long Beach, CA*

**4. Key Design Considerations for the Implementation of Variable Primary Chilled Water Pumping Systems**  
*Brandon Gill, P.E., Member, Taylor Engineers, Alameda, CA*

11:00 AM - 12:30 PM

### Seminar 32 (Intermediate)

## Novel Heat Exchangers Enabled by Shape Optimization and Additive Manufacturing

*Track: HVAC&R Systems and Equipment*



*Room: Neopolitan III/IV*

**Sponsor: 8.5 Liquid-to-Refrigerant Heat Exchangers, 1.3 Heat Transfer and Fluid Flow , TC 1.13**

*Chair: Kashif Nawaz, Ph.D., Oak Ridge National Laboratory, Oak Ridge, TN*

Heat exchangers are fundamental components of HVAC&R systems, and thus significant research efforts have focused on improving the performance of these components. In recent years, advancements in computational tools and optimization algorithms alongside advancements in additive manufacturing have expanded the horizon to improve the conventional HX design to include concepts such as topology optimization. This seminar provides an overview of the fundamentals of shape and topology optimization, modeling methods and their effect on the performance of heat exchangers.

### 1. Shape and Topology Optimized Heat Exchangers: Challenges and Opportunities

*Vikrant Aute, Ph.D., Member, University of Maryland, College Park, MD*

### 2. Heat Transfer Enhancement of Single-Phase Internal Flows Enabled by Shape Optimization and Additive Manufacturing

*William King, Ph.D., University of Illinois at Urbana-Champaign, Champaign, IL*

### 3. Topology Optimization of Fluid-Fluid Heat Exchange Systems

*Kentarō Yaji, Ph.D., Osaka University, Osaka, Japan*

11:00 AM - 12:30 PM

### Workshop 3 (Basic)

## Virtual: Best Practices of the Mentor-Mentee Relationship

*Track: Fundamentals and Applications*

**Sponsor: YEA Committee, College of Fellows**

*Chair: Shona O'Dea, Member, DLR Group, Chicago, IL*

Mentoring can be a powerful resource for personal and professional growth, not only for mentees, but for mentors as well. Are you working through a challenging new project or moving into a new role? ASHRAE members at any stage of their career will benefit from this interactive workshop. Mentorship does not just happen; it's important to be intentional about finding and nurturing relationships, both with those that fill experience gaps, but also with peers to achieve your highest potential. It's the goal of this workshop to organically connect members to develop their skills, knowledge and confidence to enhance attendees' growth.

### 1. Best Practices of the Mentor-Mentee Relationship

*Ralph Kison, Member, Growth Through Learning Inc., Vancouver, BC, Canada*

Tuesday, February 1, 1:00 PM - 1:30 PM

### Panel 2 (Basic)

## Building Automation, Cybersecurity, Artificial Intelligence, BACnet/SC and Optimizing Controls Sequences: A Panel Discussion for YEA

*Track: Fundamentals and Applications*

*Room: Milano IV*

**Sponsor: 1.4 Control Theory and Application**

*Chair: Michelle Shadpour, Member, SC Engineers, Inc., San Diego, CA*

TC 1.4 is playing a critical role in the development of building automation, cybersecurity, artificial intelligence, BACnet/SC and optimizing control sequences. Join this session to learn how each subcommittee has contributed to the discussion on many of

these topics. Moderated by the technical committee's YEA subcommittee chair, the panelists will include past committee and subcommittee chairs that are pioneers in these arenas.

1:00 PM - 2:00 PM

### On-Demand Paper Session (Intermediate)

#### Live Q&A Session 3: Energy Efficiency and Energy Recovery Solutions

*Chair: Brian M. Fronk, Ph.D., P.E., Associate Member, Oregon State University, Corvallis, OR*

##### 1. Performance Assessment of Integrated Building Envelopes Using Thermoelectric Modules for Temperature Regulation (LV-22-C057)

*Xiaoli Liu, Student Member, Ming Qu, Ph.D., Associate Member and Kazuaki Yazawa, Ph.D., Purdue University, West Lafayette, IN*

##### 2. Analysis of Heat Exchanging Performance of Rotary Thermal Wheels (LV-22-C058)

*M. Anusha Wijewardane, Ph.D., R.A. Chathura Prasad Ranasinghe, Ph.D., H.M. Dinuka P. Herath, M.D. Anuradha Wickramasinghe and A.M. Chandani K. Polgolla, University of Moratuwa, Moratuwa, Sri Lanka*

##### 3. Evaluation of an Intelligent Venetian Blind System for Building Energy Saving in Canada (LV-22-C060)

*Yue Zhao, Yousef Alipouri, Ph.D., Caitlyn Shum, Student Member and Lexuan Zhong, Ph.D., P.E., Member, University of Alberta, Edmonton, AB, Canada*

##### 4. Experimental Study on Energy Efficiency of DC Distribution System Under Varied Load Conditions (LV-22-C068)

*Gucheng Zhao, Sze Ting Chan and Yi Zhang, Future Human Habitats Division, Tsinghua Shenzhen International Graduate School, Tsinghua University, Shenzhen, China*

##### 5. Characterizing the Energy Flexibility Capacity of DC Electric Appliances Based on an Experimental Study (LV-22-C064)

*Sze Ting Chan, Gucheng Zhao and Yi Zhang, Future Human Habitats Division, Tsinghua Shenzhen International Graduate School, Tsinghua University, Shenzhen, China*

1:00 PM - 2:30 PM

### AHR Expo Session 4 (Basic)

#### System Stability and Contaminant Control with Lower GWP Refrigerants

*Track: Refrigerants and Refrigeration*

*Room: N235/N237*

##### Sponsor: 3.2 Refrigerant System Chemistry

*Chair: Rashid Zakeri, Member, Circle Proscio, Inc., Bloomington, IN*

Changes to lower global warming potential (GWP) refrigerants require investigation of these candidates with other components found within a refrigeration and air conditioning system. Studies are typically initiated under controlled laboratory testing for stability and compatibility with various lubricants, chemicals, metals and other materials of construction. This seminar presents industry efforts to screen various lower GWP refrigerant candidates through collaborative research and individual company studies. Several refrigerant and lubricant interactions are discussed along with studies on the acceptable stability and compatibility of system additives and components.

##### 1. An Update on Low GWP Refrigerant Material Compatibility and Lubricant Research

*Xudong Wang, Ph.D., Member, Air-Conditioning, Heating and Refrigeration Technology Institute, Arlington, VA*

##### 2. Filter-Drier for Contaminant Control in Air Conditioning Application of R466A

*Debasis Banerjee, Ph.D., Associate Member, Sporlan Division of Parker Hannifin, Washington, MO*

##### 3. AHRT19016 - Insights with R-32, R-1234yf, and Their Blends

*Stephen Kujak, Member, Trane Technologies, La Crosse, WI*

##### 4. Compatibility of Odorants with Refrigerant/Lubricant Systems

*Ngoc Dung (Rosine) Rohatgi, Ph.D., Member<sup>1</sup>, Eric Forsell<sup>1</sup>, Scott Ayers<sup>1</sup> and Marc Scancarello, P.E., Member<sup>2</sup>, (1)Spauschus Associates Inc., Bethlehem, GA, (2)Emerson Climate Technologies, Inc., Sidney, OH*

Tuesday, February 1, 2:45 PM - 3:45 PM

### AHR Expo Session 3 (Basic)

#### Decarbonization as it Applies to Appliance & Equipment Standards

*Track: Buildings at 360°*

*Room: N235/N237*

*Chair: William McQuade, P.E., Member, Air Conditioning, Heating and Refrigeration Institute, Arlington, VA*

Overview of current and upcoming standards and how they can be used for building decarbonization.

**1. Appliance & Equipment Standards for Building Decarbonization**

*William McQuade, P.E., Member, Air Conditioning, Heating and Refrigeration Institute, Arlington, VA*

Tuesday, February 1, 3:15 PM - 4:45 PM

**Seminar 33 (Intermediate)**

**Level Up Your Flower Game: Hydronic Design for Cannabis Grow Facilities**

*Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities*



*Room: Augustus III/IV*

**Sponsor: 6.1 Hydronic and Steam Equipment and Systems**

*Chair: David Lee, P.Eng., Member, Armstrong Fluid Technology, Toronto, ON, Canada*

Cannabis cultivation has a major dependency on its HVAC systems towards accurately controlling the indoor climate to be able to produce healthy crops at a high yield; and using hydronic systems is one of the most effective approaches to cultivation. This seminar explores the best-in-class practices on indoor climate requirements, hydronic pumping and parallel pumping strategies for reduced energy consumption, as well as psychrometric analysis of grow rooms.

**1. Indoor Climate Forecasting**

*Adam Zebrowski, PID Controls, Toronto, ON, Canada*

**2. Hydronic Pumping for Cannabis Grow Facilities**

*Tony Furst, Member, Armstrong Fluid Technology, Cape Coral, FL*

**3. Psychrometric Analysis for Cannabis Cultivation**

*Devin Lake, P.Eng., Greer Galloway Consulting Engineers, Kingston, ON, Canada*

**Wednesday, February 2**

Wednesday, February 2, 8:00 AM - 9:30 AM

**Paper Session 20**

**Virtual: Innovation in Closed Cavity Facade, Double Skin Facade and Drying Air Cavity**

*Track: Buildings at 360°*



*Room: ASHRAE Virtual Environment*

*Chair: Som Shrestha, Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN*

This session investigates different approaches to reduce the HVAC loads by studying the use of new methods when designing the facades of a building. Studies have shown that the cooling load can be reduced by more than 20% if an efficient facade is used to protect a building from weather conditions, such as the closed cavity facade with different geometrical shapes, by introducing a double skin facade which integrates a PV device that can reduce the heat gain and produce energy at the same time, or by choosing the optimum shape of a vinyl siding cladding which affects the efficacy of drying air and hence the HVAC load.

**1. Challenges and Opportunities of Using Closed Cavity Façade for Improving Energy Efficiency and Indoor Environmental Quality in Office Buildings in US Climates (LV-22-C049)**

*Michalis Michael, Associate Member<sup>1</sup> and Mauro Overend<sup>2</sup>, (1)University of Cambridge UK, Cambridge, United Kingdom, (2)Delft University of Technology, Delft, Netherlands*

**2. Potential Drying of Air Cavity Behind Vinyl Siding for Building Envelopes (LV-22-009)**

*Yanmei Xie, North Dakota State University, Fargo, ND*

**3. A Novel Process for Selecting a PCM For a Building Energy Retrofit (LV-22-006)**

*Neda Askari Tari, Arizona State University, Tempe, AZ*

**4. A Numerical Investigation of the Gap Effect on the Condensation Heat Transfer in Vertical Mini-Channels with Various Wettability Conditions (LV-22-C009)**

*Hyo Je Son<sup>1</sup>, Jae Sung Yang, M.D.<sup>1</sup>, Man Yeong Ha, Ph.D.<sup>1</sup>, Hanchoon Lee, Ph.D.<sup>2</sup>, Seungmo Jung<sup>2</sup> and June Kee Min, Ph.D.<sup>1</sup>, (1)Pusan National University, Busan, Korea, Republic of (South), (2)LG Electronics, Seoul, Korea, Republic of (South)*

8:00 AM - 9:30 AM

## Paper Session 21

### Virtual: Refining ASHRAE COVID Guidelines and Standard 100

Track: HVAC&R Systems and Equipment



Room: ASHRAE Virtual Environment

Chair: Ahmed Abdelsalam, Amazon, Dublin

ASHRAE Epidemic Task Force committee has responded quickly to the COVID-19 pandemic and released its guidelines for the safety of the public. This session explores results of building readiness assessments conducted for more than 100 commercial office buildings across the United States and recommends action where additional risk mitigation measures were warranted. The session also discusses ASHRAE Standard 100 and derives localized Standard 100 EUI targets for 11 cities across 7 climate zones using local benchmarking data collected through annual building energy benchmarking ordinances. It suggests new ideas that may be worth implementing when a region adopts Standard 100.

#### 1. From Guidance to Implementation: Applying ASHRAE Epidemic Task Force Building Readiness Strategies in 100+ Commercial Office Buildings (LV-22-C051)

Meghan McNulty, P.E., Member, Jamie Kono, P.E., Affiliate and Barry Abramson, P.E., BEAP, Member, Servidyne, LLC, Atlanta, GA

#### 2. ASHRAE Standard 100 Energy Targets Using Local Benchmarking Data (LV-22-C052)

Jamie Kono, P.E., Affiliate<sup>1</sup> and Noriaki Kono<sup>2</sup>, (1)Servidyne, LLC, Atlanta, GA, (2)Independent Researcher, Atlanta, GA

#### 3. Co-Simulation and Validation of Automated Shading Devices Using Energyplus and Radiance to Optimize Building Energy Use (LV-22-C039)

Soham Vanage, Student Member<sup>1</sup>, Niraj Kunwar, Associate Member<sup>2</sup>, Diba Malekpour<sup>1</sup> and Kristen Cetin, Ph.D., P.E., Member<sup>1</sup>, (1)Michigan State University, East Lansing, MI, (2)Oakridge National Laboratory, Oakridge, TN

#### 4. Design and Implementation of a DC-Powered Local Weather Station Picogrid for Optimal Energy Management in a Residential Building (LV-22-C012)

Jonathan Ore, Ph.D., Student Member, Aaron Farha, Student Member, Davide Ziviani, Ph.D., Member, Eckhard Groll, Dr.Ing., Fellow ASHRAE and Daniel Hagedorn, Purdue University, West Lafayette, IN

8:00 AM - 9:30 AM

### Seminar 34 (Intermediate)

### Advanced Pumping Designs for Hydronic Systems

Track: HVAC&R Systems and Equipment



Room: Milano V-VII

#### Sponsor: 6.1 Hydronic and Steam Equipment and Systems

Chair: David Lee, P.Eng., Member, Armstrong Fluid Technology, Toronto, ON, Canada

With the advancement of technologies and availability of pumps with built-in intelligence, PMS motors with high efficiency and control logic, a new way of hydronic pumping design is possible. A major concern in earlier times has been on resilience of pumps when introducing more technology. With the intelligent pump, resilience is not an issue with validated long lifetime expectancy. Distributing secondary pumps and controlling primary pumps to balance primary flow with secondary flow has been mentioned and described for decades but with the intelligent pumps there is viable solution on efficient chilled water pumping.

#### 1. Theory and Concepts Behind

Agisilaos Tsouvalas, Grundfos Holding A/S, Midtjylland, ON, Denmark

#### 2. A Case Story from Singapore: Ngee Ann Polytechnic

Sam Lam, CEng, Member, Ngee Ann Polytechnic, Singapore, Singapore

#### 3. A Digital Twin Approach: What Energy Modelling Can Provide Us

Ben Davis, P.E., Member, VBFA, Kahuku, UT

8:00 AM - 9:30 AM

### Seminar 37 (Intermediate)

### Reduced Order Modeling for HVAC&R Systems and their Components

Track: HVAC&R Systems and Equipment



Room: Augustus III/IV



### **Sponsor: 8.1 Positive Displacement Compressors, 8.2 Centrifugal Machines**

*Chair: Alex Schmig, Member, Trane, La Crosse, WI*

This seminar will focus on methods and advantages of simplifying physical analytical models to reduced order models that can be implemented and adapted for use in system models or for standalone analysis. Presenters focus on differing approaches to reduce modeling complexity and decrease computational intensity. Topics explore modulation and extrapolation of reduced order compressor models, uncertainty propagation, adaptability to new low-GWP refrigerants, simulated cycle modeling and validation of reduced order models.

#### **1. Application of Data-Driven Models for Positive Displacement Compressor Mapping**

*Davide Ziviani, Ph.D., Member, Purdue University, West Lafayette, IN*

#### **2. Semi-Empirical Compressor Model Evaluation Considering Modulation and Extrapolation Performance**

*Kalen Gabel, Student Member, Center for Integrated Building Systems, Oklahoma State University, Stillwater, OK*

#### **3. Reduced-Order Modeling and Fast Simulation of Transient Vapor Compression Cycles**

*Jiacheng Ma, Student Member, Purdue University, West Lafayette, IN*

Wednesday, February 2, 9:45 AM - 10:45 AM

### **Panel 3 (Basic)**

## **AIM Act Impact on Commercial Refrigeration and Technology Opportunities**

*Track: HVAC for Industrial and Commercial Purposes - Challenges and Opportunities*

*Room: Milano I-III*

*Chair: David Reitz, Matelex/Climalife, Paris and New Haven, CT USA., France*

This panel will explore the impact/opportunity of the AIM Act on commercial refrigeration through a discussion with a broad panel including a senior policy analyst, IoT technology company and refrigerant design install company. The purpose of this session is to increase the awareness of the AIM Act, provide latest details on how the act will be enforced/supported and to provide examples/discussions on opportunities. The 2020, AIM Act requires the EPA to develop a system to aggressively phase down the consumption of HFCs. The Act relies on four central mechanisms data collection, allowance trading, sector-specific technology transitions, and refrigerant management practices.

#### **1. AIM Act Impact on Commercial Refrigeration and Technology Opportunities II**

*Elodie Delonca, Matelex/Climalife, Paris and New Haven, CT USA., France*

#### **2. AIM Act Impact on Commercial Refrigeration and Technology Opportunities III**

*Michael May, Member, Effecterra, Reno, NV*

9:45 AM - 10:45 AM

### **Paper Session 22**

## **Implementing and Optimizing Smart Local Energy Systems**

*Track: Energy System Integration*



*Room: Neopolitan I/II*

*Chair: Raul Simonetti, Member, Carel Industries SpA, Brugine, Italy*

Smart local energy systems (SLES) that integrate heat, power and mobility vectors are part of the UK strategy to reach net zero carbon by 2050. The papers in this session investigate the opportunities and challenges for implementing SLES in UK cities and towns through case studies and provide an overview of a systematic approach for the optimization of SLES using central London as a case study.

#### **1. A Systematic Optimisation Approach of Smart Local Energy Systems in Cities (LV-22-C053)**

*Akos Revesz, Ph.D., Affiliate<sup>1</sup>, Phil Jones, CEng<sup>2</sup>, Chris Dunham<sup>3</sup>, Catarina Marques, Ph.D.<sup>1</sup> and Graeme Maidment, Ph.D., P.E.<sup>1</sup>, (1)London South Bank University, London, United Kingdom, (2)Building Energy Solutions; London South Bank University, London, philjones100@virginmedia.com, (3)Carbon Descent Projects, London, United Kingdom*

#### **2. Opportunities and Challenges for Implementing Smart Local Energy Systems in Cities and Towns, Demonstrated through Case Studies (LV-22-C054)**

*Ana Catarina Marques, Ph.D., Member<sup>1</sup>, Helen Turnell, Ph.D.<sup>2</sup>, Phil Jones<sup>3</sup>, Chris Dunham<sup>4</sup>, Akos Revesz, Ph.D., Affiliate<sup>2</sup> and Graeme Maidment, Ph.D., P.E.<sup>2</sup>, (1)London South Bank University, Norwich, United Kingdom, (2)London South Bank University, London, United Kingdom, (3)Building Low Carbon Solutions, London, United Kingdom, (4)Carbon Descent Projects, London, United Kingdom*

9:45 AM - 10:45 AM  
**Seminar 39 (Intermediate)**

## **Transmission of Aerosols in Dental Treatment Rooms**

*Track: Environmental Health and IEQ in the International Arena*



*Room: Augustus III/IV*

**Sponsor: MTG.ACR, 9.10 Laboratory Systems , Co-sponsor: TC 9.6 Healthcare Facilities**

*Chair: Amit Bhansali, WSP, Irving, TX*

Airflow patterns play an important role in determining the flow path of aerosol transmission. The spread and accumulation of aerosols in dental treatment rooms, including pathogens and other harmful byproducts, can depend on several design and operating parameters related to HVAC system. The seminar presents CFD studies that demonstrate the impact of airflow patterns on the spread of aerosols and resulting probability of infection. With experimental tests and CFD, it also discusses the evaluation of air management and role of local extract devices in mitigating the spread of aerosols and control of infection within the spaces of dental treatment rooms.

### **1. Transmission of Aerosols in Dental Treatment Rooms**

*David J Ahearn<sup>1</sup> and Michael Wetzel, P.E., Member<sup>2</sup>, (1)Design Ergonomics, Inc., Little Compton, RI, (2)Air Innovations, North Syracuse, NY*

9:45 AM - 10:45 AM  
**Forum 4**

## **The Future of Thermally Driven Heat Pumping and Cooling in the Age of Decarbonization**

*Track: Energy System Integration*

*Room: Neopolitan III/IV*

**Sponsor: 8.3 Absorption and Heat Operated Machines**

*Chair: Kyle R. Gluesenkamp, Kyle R., Ph.D., Member, Oak Ridge National Laboratory, Oak Ridge, TN*

This forum covers a discussion of the future of heat operated heat pumps and cooling systems, and focus on how these technologies can participate and can be correctly evaluated on both efficiency and environmental terms in a low carbon future.

Wednesday, February 2, 11:00 AM - 12:30 PM  
**Seminar 40 (Intermediate)**

## **Climate Change Considerations in Energy Audits**

*Track: Buildings at 360°*



*Room: Milano V-VII*

**Sponsor: 2.5 Global Climate Change, 7.9 Building Commissioning , TC4.2**

*Chair: Scott Sherwood, Eco Care Corporation, New York, NY*

As climate change impacts our built environment today, ASHRAE members seek to improve design of tomorrow's buildings. Projections of energy consumption, conservation opportunities and return on investments calculations rely on averaged historic weather files, consistent energy rate increases and utility choices. This session unpacks energy modeling and analysis assumptions with a focus on climate change impacts.

### **1. Incorporating Project Climate Change Information into Building Design and Analysis**

*Parag Rastogi, Ph.D., Member, arbnco ltd, Glasgow, United Kingdom*

### **2. Predictive Energy Modeling for a Changing Climate**

*Pierre Khalil, P.E., Member, Metrus Energy, Minneapolis, MN*

### **3. Corporate Considerations of Future Climate Change: ESG Scope I-III Calculations**

*Daniel Katzenberger, P.E., BEMP, Member, Best Buy, Minneapolis, MN*

11:00 AM - 12:30 PM

**Seminar 41 (Advanced)**

**Design Challenges to the Electrification of Heating in Mid to Large Buildings**

*Track: Energy System Integration*



*Room: Milano I-III*

**Sponsor: 8.2 Centrifugal Machines, 2.8 Building Environmental Impacts and Sustainability**

*Chair: Raymond Good Jr., P.E., Member, Danfoss Turbocor Compressors, Inc., Tallahassee, FL*

Electrification of heating is becoming an imperative based on a desire to reduce heating with fossil fuels and in some cases to meet codes and standards enacted to reduce greenhouse gas emissions. This seminar introduces some of the basic concepts and driving forces behind the current and developing trend of electrified heating. It also explores some of the technologies available and share specific design and control strategies that make the dream a reality.

**1. Fundamentals and Technologies of Heating Electrification**

*Trent Hunt, Member<sup>1</sup> and Drew Turner<sup>2</sup>, (1)Mechanical Products NSW, Salt Lake City, UT, (2)Danfoss, Baltimore, MD*

**2. Time Independent Energy Recovery: The Solution to Large Building Electrification**

*Brandon Gill, P.E., Member, Taylor Engineers, Alameda, CA*

**3. The Ins and Outs of Heat Recovery Chiller Sizing and Control**

*Chris Miller, P.E., Member, P2S, Inc., Long Beach, CA*

11:00 AM - 12:30 PM

**Seminar 42 (Intermediate)**

**Humidifiers for Health and Comfort: Installation and Use Considerations**

*Track: HVAC&R Systems and Equipment*



*Room: Neopolitan III/IV*

**Sponsor: 5.11 Humidifying Equipment, 5.7 Evaporative Cooling**

*Chair: Steven Slayzak, Associate Member, Seeley International, Denver, CO*

The current pandemic has highlighted the importance of IEQ for the health and comfort of building occupants. Humidification is one of the fundamental air parameters that contributes to the reduction of transmission of airborne pathogens and, when combined with increased air changes, helps contain the concentration of pathogens within acceptable limits. In addition, optimal humidity levels guaranty proper comfort and improved human health and immune response. This session explains how to install, retrofit, run and maintain humidification systems in various types of buildings (e.g., health-care facilities, museums, etc.) so that they can consistently contribute to IEQ.

**1. Steam Humidification Systems: How to Get the Best Results**

*David Baird, Member, Dristeam Corporation, Eden Prairie, MN*

**2. Adiabatic Humidification Systems: How to Get the Best Results**

*Duncan Curd, Member, DriSteam, Eden Prairie, MN*

**3. Indirect-Direct Cooling: An Optimum Humidity Opportunity**

*Edgar Necochea, P.E., Seeley International Pty Ltd, Sacramento, CA*

**4. Clean and Under Control: Getting Humidifier Maintenance Right**

*Thomas Klein, Condair Ltd., Lancaster, PA*

11:00 AM - 12:30 PM

**Seminar 43 (Advanced)**

**Latest Developments in Low-GWP Refrigerants, Systems for Refrigeration and Related Regulations**

*Track: Refrigerants and Refrigeration*

*Room: Neopolitan I/II*

**Sponsor: 10.7 Commercial Food and Beverage Refrigeration Equipment, 3.1 Refrigerants and Secondary Coolants , 8.1; 10.6, REF Committee**

*Chair: Stephen Schaefer, Hoshizaki, Peachtree City, GA*

Flammable refrigerants are playing an increasing role in reducing the environmental impact of refrigeration and air-conditioning. However, their safe use requires new approaches in the design of the systems and equipment in compliance with

the new and improved standards and safety regulations. This seminar presents the latest developments in the low-GWP refrigerants and systems for refrigeration, as well as the updated on the related regulations.

**1. Global View on the Implementation of Flammable Refrigerants in Refrigeration and Air-Conditioning**

*Rajan Rajendran, Ph.D., Associate Member, Emerson Climate Technologies, Inc., Dayton, OH*

**2. Transition to Low Global Warming Potential Refrigerants in Light Commercial and Residential Air Conditioning**

*Helen Walter-Terrinoni, Air-Conditioning, Heating, and Refrigeration Institute, Arlington, VA*

**3. Updates on ASHRAE Standard 15**

*Tim Anderson, Associate Member, Hussmann, Bridgeton, MO*

**4. Update on UL Standards**

*Brian Rodgers, Underwriters Laboratories, Northbrook, IL*

11:00 AM - 12:30 PM

**Seminar 44 (Intermediate)**

**Upgrading Existing Building Control Systems for High Performance Operation**

*Track: Buildings at 360°*



*Room: Augustus III/IV*

**Sponsor: 1.4 Control Theory and Application, 7.6 Building Energy Performance , 2.8 Building Environmental Impacts and Sustainability**

*Chair: Gregory Cmar, Member, Interval Data Systems, Boston, MA*

The Commonwealth of Kentucky evolved an approach to upgrading existing buildings that not only yields high performance (based upon Guideline 36 SOO) and better-quality delivery of automation, but does so repeatedly across multiple manufacturers' BASs. Buildings are retrofit with far fewer operational deficiencies and operate consistent with design intent much earlier in warranty period. The seminar takes you through KY's program for better quality automation and the role of the owner, engineer, and verification of performance—and it started with G36.

**1. Upgrading Building Control Systems for High Performance Operation across a Portfolio**

*Dick Mink, Commonwealth of Kentucky, Frankfort, KY*

**2. Designing, Specifying and Managing High Performance Controls Upgrades into a Centralized System**

*Casey Wilson, Member, CMTA, Inc., Louisville, KY*

**3. Verifying Control System Performance Using Data, a Digital Twin, and Easy to Understand Analytics**

*Kevin Fuller<sup>1</sup> and Bill Gnerre, Member<sup>2</sup>, (1)Interval Data Systems, Boston, MA, (2)Interval Data Systems, Waltham, MA*