



Shaping Tomorrow's
Built Environment Today

ASHRAE International Building Decarbonization Conference 2024

April 17 - April 19, 2024

Madrid, Spain



Preliminary Technical Program

Updated: 27 February 2024

Wednesday, April 17

Wednesday, April 17, 8:30 AM - 9:30 AM

Keynote 1 (Intermediate)

ASHRAE's Decarbonization Activities

Room: Garnacha II and III

Chair: Marianna Vallejo, PhD, Full Member, Jacobs, Athens, Greece

ASHRAE's Decarbonization Activities

Ginger Scoggins, Engineered Designs Inc, Cary, NC

Wednesday, April 17, 9:50 AM - 11:20 AM

Round Table 1 (Basic)

International Associations' Building Decarbonization Efforts

Room: Garnacha II and III

Chair: Ginger Scoggins, Engineered Designs Inc, Cary, NC, Catalin IOAN Lungu, PhD, REHVA President, Bucharest, Romania, Lakisha Woods, The American Institute Architects, Francesco Scuderi, Eurovent, Brussels, Belgium, Julie Godefroy, Head of Net Zero Policy, CIBSE, Bedford, United Kingdom, Pedro G. Vicente Quiles, Atecyr Technical Committee President, Spain and Marianna Vallejo, PhD, Full Member, Jacobs, Athens, Greece

Building industry collaboration can have a critical role in educating and training industry professionals and stakeholders on building decarbonization strategy, policies and practices. Representatives from AIA, ASHRAE, CIBSE, EuroVENT, IFMA, and REHVA provide an overview of their organization's building decarbonization activities; discuss why building decarbonization is important for their members; and share how greater industry collaboration can accelerate building decarbonization planning and progress.

9:50 AM - 11:20 AM
Conference Paper Session 1

The Designer's Obligation?

Room: Garnacha IV

Chair: Eduardo A B Maldonado, Life Member, Fac Engenharia Univ Porto, Porto, Portugal

What should be the role of designers and planners towards decarbonizing the building projects they are developing? This session addresses the ethical and professional posture that every designer should adopt in their work, and it describes the strategies and methodologies that those responsible for two specific interesting case studies, one building and one university campus, adopted towards reaching a clear goal of a zero-carbon future.

Learning Objectives:

1. Understand sustainable urban redevelopment practices involved in transforming existing spaces into eco-friendly, resilient community hubs.
2. Analyze carbon reduction strategies employed in urban development projects.
3. Understand the key issues with decarbonization of the built environment
4. Distinguish key reasons why the design team should include decarbonization in the building design as well as the key issues why they should leave that up to the owner to decide.
5. Describe the importance of monitoring advanced HVAC systems to optimize the energy efficiency.
6. Explain the benefits and limitations of designing a 2-pipe change-over system.

1. Boulder West City Campus: A Glimpse into a Decarbonized Future and High Performance Design

Carlos Kelly¹, Michelle Crane² and Chris Chatto, AIA³, (1)BranchPattern, Pittsburgh, PA, (2)City of Boulder, Boulder, CO, (3)ZGF Architects, Portland, OR

2. Do Building Designers Have an Obligation to Promote Decarbonization in Their Projects?

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

3. The Blue House with Green Ambitions: A Case Study

Ulf Horman, Swegon Group, Malmö, Sweden

9:50 AM - 11:20 AM
Conference Paper Session 2

District-Scale Heat Pump Application

Room: Garnacha I

Chair: Raul Simonetti, Full Member, CAREL Industries SpA, Brugine, Italy

The application of heat pump technology at larger scales has the potential to reduce the environmental cost of heating buildings. The first paper investigates the community-scale application of heat pumps in residential homes in a heating-dominated climate (Lake County, Colorado, U.S.). The second examines an application integrated with thermal storage in Scandinavia.

Learning Objectives:

1. Identify different models for CO2 emissions calculations
2. Explain how electrification and retrofits can reduce carbon emissions
3. Provide an overview of thermal-electrical network coupling
4. Design a standardized framework for thermal-electrical network coupling

1. Energy and Operational Carbon Savings in Community Scale Low-Carbon Retrofit with Dual Source Cold Climate Heat Pumps

Paulo Cesar Tabares Velasco, S-B-a Member and Karllye Dais Munz, Colorado School of Mines, Golden, CO

2. District-Level Load Flexibility Towards Decarbonization Leveraging Heat Pumps and Thermal Energy Storage

Yangzhe Chen¹, Thomas Ohlson Timoudas, PhD² and Qian WANG, PhD¹, (1)KTH, Royal Institute of Technology, Stockholm, Stockholm, Sweden, (2)RISE Research Institutes of Swede, Stockholm, Stockholm, Sweden

Impact of New EPBD and European Standards Toward Heat Pumps

Martin Dieryckx, Fellow ASHRAE, Daikin, Torhout, Belgium

Wednesday, April 17, 11:30 AM - 12:30 PM

Round Table 2 (Advanced)

Delivering NZC Office Buildings: Spanish Real Estate Vision

Room: Garnacha I

Chair: Javier Dorao, Crea Madrid Nove Norte, Madrid, Spain, Mark Fenwick, AIA, Fenwick Iribaren Architects, Madrid, Spain, Mariano Garcia, Garcia Consulting Engineers MD, Madrid, Spain, Alejandro Miguel Vicente, Acciona, Madrid, Spain, Almudena Génova Fuster, BOVIS from CBRE, Madrid, Spain and Tomas Higuero, M.D., Aire Limpio Group MD, Madrid, Spain

Spain's approach to the decarbonization of its tertiary building sector in 2024 comprises a strategic multi-faceted approach. These include the reduction of embodied carbon, which accounts for a significant contribution of sector emissions, and promoting circular economy principles for minimizing construction waste and encouraging material reuse. Smart building technologies are increasingly adopted to optimize resources and energy efficiency in both new projects and existing buildings. Efforts are also directed towards improving the energy efficiency and the indoor environmental quality of both existing and new buildings through rigorous energy / IAQ performance standards and retrofitting initiatives.

11:30 AM - 12:30 PM

Conference Paper Session 3

Strategies for Incorporating Low GWP Refrigerants

Room: Garnacha IV

Chair:

Learning Objectives:

1. Explain how rotary gas pressure exchanger does expansion work recovery.
2. Design trans-critical CO₂ air-conditioning and refrigerating systems integrated with rotary gas pressure exchanger.
3. Understand data analysis for vapor compression systems (central air-conditioners and heat pumps) scenario.
4. Determine alternatives with lower GWP for retrofitting R410A systems without compromising the performance or the exergy efficiency.

1. Novel Expansion Work Recovery Machine for Trans-Critical CO₂ Air Conditioning: A Path to Decarbonization of Residential and Industrial Cooling Using Low GWP Refrigerants

Azam Thatte, Full Member¹, Brian A Fricke, Oak Ridge National laboratory, Fellow Member² and Kashif Nawaz, PhD, Associate³, (1)Energy Recovery, San Leandro, CA, (2)Oak Ridge National Laboratory, Oak Ridge, TN, (3)Oak Ridge National Lab, Oak Ridge, TN

2. Exergy and Performance Analysis of Alternative Refrigerants with Lower GWP for the Retrofit of Heat Pumps with R410A

Pedro Barandier, Student and Antonio Joao Marques Cardoso, CISE - Electromechatronic Systems Research Centre, Covilhã, Portugal

3. Field Performance and Embodied Carbon Evaluation of Cold Climate Heat Pumps Using Low GWP Refrigerant

Jeremy Sager and Charles Mougeot, CanmetENERGY, Ottawa, ON, Canada

11:30 AM - 12:30 PM

Seminar 1 (Basic)

Driving Decarbonization: ASHRAE's Path to Whole Life Carbon Emission Reductions

Room: Garnacha II and III

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

This seminar presents an essential update on ASHRAE's pivotal role in advancing building decarbonization policies and practices, both nationally in the United States and on a global scale. Led by ASHRAE's Task Force for Building Decarbonization (TFBD), this session delves into multifaceted strategies and initiatives aimed at reducing whole life carbon emissions within the built environment. Specifically, this seminar provides an overview of the whole life cycle of carbon emissions in buildings and the critical role of codes and standards.

Learning Objectives:

1. Define Whole Life Carbon
2. Identify the complexities associated with whole life carbon reduction
3. Provide an overview of future building decarbonization practices
4. Describe ASHRAE's initiatives

1. Whole Life Carbon Overview

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

2. Codes and Standards

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

3. Whole Life Carbon: Practitioner Point of View

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

4. Refrigerants and Manufacturers

William F McQuade, P.E., LEED® AP, FASHRAE, LEED AP PE, Member, Baltimore Aircoil Company, Jessup, MD

Wednesday, April 17, 2:00 PM - 3:00 PM

Round Table 3 (Basic)

Global Perspectives on Decarbonization

Room: Garnacha II and III

Chair: Marianna Vallejo, PhD, Full Member, Jacobs, Athens, Greece, Esteban Baccini, BACCINI HVAC & Energy Efficiency Consulting, Buenos Aires, Argentina, Erich Binder, Erich Binder Consulting Limited, Calgary, ON, Canada, Chandana Dalugoda, Fellow ASHRAE, Chandana Dalugoda Consultants, Makuluduwa, Sri Lanka, Samir R Traboulsi, PhD., P. Eng., Fellow Life Member, Thermotrade/Ranec, Beirut, Lebanon, Kimberly Dowdell, American Institute of Architects, Washington, DC and Kan Shindo, Student, Waseda University, Tokyo, Japan

This discussion considers perspectives from around the world on what is or is not working, practically, for decarbonizing the built environment. Panelists discuss their regional and local policies, lessons learned and best practices.

2:00 PM - 3:00 PM

Conference Paper Session 4

The Path to Carbon Neutral Hospitals

Room: Garnacha IV

Chair: Joseph T Firrantello, Ph.D., P.E., Full Member, McKinstry, Seattle, WA

Learning Objectives:

1. Provide structured consulting engineering services for CO2 reduction strategies
2. Benchmark specific hospital energy data against the information provided in the session

1. A Roadmap to the Carbon Neutral Hospital

Juan Gallostra Sr., Member, JG Ingenieros, Barcelona, Spain

2:00 PM - 3:00 PM

Conference Paper Session 5

Life Cycle Carbon Case Studies

Room: Garnacha I

Chair: Thomas M Lawrence, PhD, Fellow Life Member, University of Georgia, ATHENS, GA

The first case study focuses on the technical systems in order to quantify the embodied carbon of several HVAC systems in a high-performing building under different weather conditions in Turkey. Another case study performs a comparative environmental impact assessment of a balanced ventilation system with heat recovery and a demand-controlled exhaust ventilation system, with a detailed inventory of all system components, under four ventilation scenarios in a single-family dwelling.

Learning Objectives:

1. Understand the importance of individual components in the design of ventilation systems.
2. Understand the trade-offs between embodied impact and operational energy use in exhaust and balanced ventilation.
3. Describe how HVAC systems have an impact on embodied carbon of buildings
4. Distinguish solutions for better overall carbon emissions while designing HVAC systems for nZEBs

1. Comparative LCA of an Exhaust and Balanced Ventilation System: A Single-Family Case Study in Flanders

Yanaika Decorte, Marijke Steeman and Nathan Van Den Bossche, Ghent University, Ghent, Belgium

2. Whole-Life Carbon Assessment of HVAC Systems for Nearly Zero Energy Buildings
Cihan Nuri Kayacetin, PhD, Bilkent University, Ankara, Turkey

Wednesday, April 17, 3:30 PM - 4:30 PM
Conference Paper Session 6

Coordinating Energy Use Using IoT Infrastructure

Room: Garnacha I

Chair:

Data collected from connected appliances and equipment at a community scale enables us to make better choices about how and when we consume energy. The first paper uses data collected by smart plugs and smart meters to identify the best periods to run electric appliances using an optimization routine. The second paper uses collected data and deep learning to schedule heat pump and thermal energy storage use one day in advance.

Learning Objectives:

1. Design a holistic IoT-driven architecture for optimizing electricity usage in buildings.
2. Apply machine learning-driven load disaggregation techniques utilizing pattern identification algorithms and knapsack optimization.
3. Implement smart energy trading strategies in energy communities using IoT.
4. Assess the impact of energy flexibility in a sector coupling system.

1. IoT-Enabled Data-Driven Approach: Appliance Clustering and Load Disaggregation for Smart Building Appliance Scheduling

Saeed Misaghian, Giovanni Tardioli, PhD, Associate, Nisha P, Beatriz Fraga De Cal and Simeon Oxizidis, PhD, IES Ltd, Dublin, Ireland

2. Empowering Sustainable Energy Communities with IoT: A Case Study of Demand Response Management in Großschönau Municipality

Mustapha Habib, PhD and Qian WANG, PhD, KTH, Royal Institute of Technology, Stockholm, Stockholm, Sweden

3:30 PM - 4:30 PM
Seminar 2 (Basic)

Certified Decarbonization Professional: An Information Session

Room: Garnacha IV

Sponsor: Certification Committee

Chair: Drury B Crawley, PhD, Member, Bentley Systems, Inc., Washington, DC

ASHRAE's new Certified Decarbonization Professional (CDP) certification validates competency to decarbonize a building throughout its entire life cycle. This initiative was set in motion by the ASHRAE Task Force for Building Decarbonization (TFBD) in order to support ASHRAE building decarbonization efforts. This will be an informative session to introduce the new certification and allow for a discussion of the requirements and benefits.

Attendance at this information session is recommended for all stakeholders in the built environment industry, including designers, builders, building owners, facility operators and government officials.

Learning Objectives:

1. Describe CDP eligibility requirements.
2. Describe the certification application process.
3. Provide an overview of the knowledge areas covered by the CDP.
4. Relate the value of certification.

1. Ashrae Certified Decarbonization Professional (CDP) Certification

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

3:30 PM - 4:30 PM

Seminar 3 (Intermediate)

Decarbonizing the Built Environment: Global Policies, Local Impacts and Climate Resilience

Room: Garnacha II and III

Chair: Douglas C Cochrane, P.Eng., Full Member, Independent Consultant, Toronto, ON, Canada

This session delves into decarbonization of the built environment, addressing the challenges posed by diverse global policies and mandates. We explore inconsistency across building regulations, impact on practitioners, alongside a review of global decarbonization goals and metrics. The session emphasizes the critical need for climate resilience and adaptation in design and construction. Insights into climate drivers, resilience measures across diverse geographies, and the pivotal role of the built environment as a solution to the climate crisis are discussed. Additionally, we introduce ASHRAE's future standards, ensuring consistent, fuel-agnostic greenhouse gas accounting and reporting for the global building industry.

Learning Objectives:

1. Understand the challenges and risks faced by practitioners due to diverse global policies in the context of decarbonizing the built environment.
2. Analyze the impact of inconsistent building regulations and mandates on the practice of building design and manufacturing.
3. Describe global decarbonization goals, regulations metrics and their implications for building professionals.
4. Understand the imperative for climate resilience and adaptation in building decarbonization efforts and identify key policy dimensions supporting a sustainable future built environment.

1. Policy and Regulation for Decarbonizing the Built Environment: Global Perspectives and Local Impacts

Elizabeth Tomlinson, Stantec, Minneapolis, MN

2. Climate Resilience and Adaptation in Building Decarbonization: Lessons from Changing Environments

Francis K Wiese, PhD, Stantec, Anchorage, AK

Wednesday, April 17, 4:40 PM - 5:40 PM

Conference Paper Session 7

The Era of Life Cycle Carbon Standards and a Case Study

Room: Garnacha II and III

Chair:

An ASHRAE Distinguished Lecturer reveals the insights of the new carbon standards, including an overview of different methodologies and examples for counting of carbon, and the main steps on how to reduce carbon emissions holistically. A case study also analyzes numerous construction options in a prototypical energy-code-minimal house and combines with different decarbonization rates of electricity supply and refrigerant leakage to demonstrate the sensitivity and relationship of embodied and operational carbon.

Learning Objectives:

1. Describe how tradeoffs between embodied and operational carbon are significant.
2. Identify ways that tradeoffs between embodied and operational carbon may be counterintuitive.

1. The New Carbon Standards: Towards Net Zero Operational, Embodied, Upfront and Whole Life Carbon

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

2. A Case Study in the Tradeoffs of Operational and Embodied Carbon in the Design of a Near-Zero Energy Residence in Medium and Cold Climates in the USA

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

4:40 PM - 5:40 PM

Conference Paper Session 8

Decarbonization for Low Income Housing

Room: Garnacha I

Learning Objectives:

1. Understand how Philadelphia implemented the energy efficiency program for low-income urban households.
2. Determine if a similar program is possible in their locale.
3. Describe the impact of renovation strategies on the whole-life carbon emissions of a building, including both upfront embodied emissions and operational carbon emissions.
4. Apply a science-based approach in assessing building decarbonization measures to avoid unexpected shortcomings over the lifetime of the asset.

1. One House at a Time: Implementing Energy Efficiency and Decarbonization in Low Income Urban Households

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

2. Whole-Life Carbon Assessment and Cost Analysis for the Renovation of Social Housing Buildings in Ireland

Lorenzo De Donatis, CEng and Olivier Neu, PhD, Associate Member, IES Ltd, Dublin, Ireland

4:40 PM - 5:40 PM

Conference Paper Session 9

Photovoltaic Low Energy Waste Heat and Community-Scale Data Analysis

Room: Garnacha IV

Chair:

This session presents two different papers linked by an overarching topic: photovoltaic (PV) systems. The first investigates methods for reclaiming the low-exergy waste heat inherent in PV applications. The second is an analysis of use patterns in a community-scale PV and battery system consisting of 75 grid-connected, single-family homes.

Learning Objectives:

1. Evaluate the integration strategies of air-PVT systems with low-exergy systems.
2. Analyze the potential of various air-PVT integration strategies for enhancing building energy efficiency.
3. Learn the in-situ performance of home PV/battery installations in cold-climate regions, including two modes of operation: backup reserve and time-based control.
4. Understand the battery programming and its simulation algorithm using discrete-event simulation.

1. Feasibility Analysis and Evaluation Framework of Integrating Novel PVT with Low-Exergy Systems

Youssef Elomari¹, Giorgos Aspetakis¹, Marc Marin Genescà², Dieter Boer² and Qian WANG, PhD³, (1)KTH Royal Institute of Technology, Stockholm, Sweden, (2)Departament d'Enginyeria Mecànica, Universitat Rovira i Virgili, Tarragona, Spain, (3)KTH, Royal Institute of Technology, Stockholm, Stockholm, Sweden

2. Performance Evaluation of 75 Residential Rooftop Solar Photovoltaic and Battery Systems: A Cold-Climate Comparison for Time-Based Control and Backup Reserve Modes of Operation

Hadia Awad, PhD¹, Ajit Pardasani² and Scott Garinther³, (1)National Research Council, Ottawa, ON, Canada, (2)National Research Council Canada, Ottawa, ON, Canada, (3)NB Power, Fredericton, NB, Canada

Thursday, April 18

Thursday, April 18, 8:00 AM - 9:00 AM

Keynote 2 (Intermediate)

Keynote Presentation

Room: Garnacha II and III

Chair: Marianna Vallejo, PhD, Full Member, Jacobs, Athens, Greece

Keynote 2

Paula Rey Garcia, European Commission, Brussels, Belgium

Thursday, April 18, 9:10 AM - 10:30 AM

Round Table 4 (Intermediate)

The EU Renovation Wave: Status, Challenges and Future Perspectives

Room: Garnacha II and III

Chair: Eduardo A B Maldonado, Life Member, Fac Engenharia Univ Porto, Porto, Portugal, Paula Rey Garcia, European Commission, Brussels, Belgium, Andrew Warren, British Energy Efficiency Federation, Cambridge, United Kingdom, Catalin IOAN Lungu, PhD, REHVA President, Bucharest, Romania, Julie Godefroy, Head of Net Zero Policy, CIBSE, Bedford, United Kingdom and Marta San Roman, AFEC, Madrid, Spain

Meeting the EU target to have a fully decarbonized buildings sector by 2050 carries important technical, logistical, financial and social impacts. This roundtable addresses existing buildings and the renovation wave for both the residential and nonresidential sectors from different perspectives: policymakers, industry, design engineers and stakeholders. How is Europe doing so far and how each sector sees the future and their own role to reach the desired and challenging policy target? Is there sufficient skilled workforce? Will we be able to afford this change? Who will pay? Will we need carrots or sticks, or a combination of both?

9:10 AM - 10:30 AM

Conference Paper Session 10

Reducing Carbon Footprint in Developing Economies

Room: Garnacha IV

Chair: Raul Simonetti, Full Member, CAREL Industries SpA, Brugine, Italy

Learning Objectives:

1. Describe how various combinations of lightweight walling and roofing materials can be used with or without insulation to minimize thermal discomfort and embodied carbon emissions in naturally ventilated housing.
2. Apply the use of various emerging lightweight construction materials and technologies on a large scale.
3. Describe the most feasible technologies to electrify communities in Sub-Saharan Africa.
4. Describe the most financially-feasible technologies to electrify communities in Sub-Saharan Africa.

1. Reducing Carbon Footprint of Buildings in Developing Economies

Chandana Dalugoda, Fellow ASHRAE, Chandana Dalugoda Consultants, Makuluduwa, Sri Lanka

2. A Comparative Study of Embodied Carbon and Thermal Performance of New Lightweight Construction Technologies with Respect to Conventional Construction Technology in Affordable Housing in India

Gunjan Jain, Shweta Manchanda, PhD, Mandeep Singh, PhD, Aritro De and Shuvojit Sarkar, PhD, School of Planning and Architecture, Delhi, India

3. Leapfrogging Towards Distributed Energy Systems: The Case of Khartoum, Sudan

Amr Suliman, Full Member¹ and Mahroo Eftekhari, CEng, Full Member², (1)University of Oxford, Oxford, United Kingdom, (2)Loughborough University, Loughborough, United Kingdom

9:10 AM - 10:30 AM

Conference Paper Session 11

Occupant Comfort-Driven Methodologies and Calculations

Room: Garnacha I

Chair: Thomas M Lawrence, PhD, Fellow Life Member, University of Georgia, ATHENS, GA

Exploring different occupant-centric methods and calculations can also lead to significant energy and emission savings in buildings. A modified degree-day type calculation approach uses the equivalent outside temperature to perform cooling calculations during the building occupancy hours, while accounting for indoor comfort conditions. A novel occupant comfort-centric approach for next day demand side management scenarios uses a two-step optimization approach to identify optimal operational schedules that can lead to 7-10% lower cost and emissions.

Learning Objectives:

1. Formulate an optimization problem for demand side management of residential buildings.
2. Apply data-driven methods and building physics simulations for demand side management operations of residential buildings to consider occupant comfort.
3. Evaluate potential applications of the proposed methodology.
4. Describe the potential application of AI for saving energy.

1. An Occupant Comfort-Centric Demand Side Management Approach Based on Data-Driven Methods and Building Digital Twins

Giovanni Tardioli, PhD, Associate¹, Saeed Misaghian², Nisha P², Beatriz Fraga De Cal², Dimitrios Ntimos³, Niall Byrne¹, Simeon Oxizidis, PhD² and Donal Finn¹, (1)Integrated Environmental Solutions (IES), dublin, dublin, Ireland, (2)IES Ltd, Dublin, Ireland, (3)IES Ltd., Dublin, Ireland, (4)University College Dublin, Dublin, Ireland

2. Shifting Paradigm: Exploring Energy Savings through Comfort-Driven Approaches

Angelo Martucci Sr., Arup, Madrid, Spain

3. Upgrading Thermal Comfort Theory Aiming to Attain Low-Carbon Buildings Under Climate Change

Ali Reza Haddadi, P.E.¹ and Esmail Jalali Lavasani, Ph.D., P.E.², (1)3nanosae, Tehran, Iran (Islamic Republic of), (2)3nanosae, Măgurele, Romania

Thursday, April 18, 11:00 AM - 12:30 PM

Round Table 5 (Advanced)

Carbon Neutrality in the Digital Age: Pioneering Strategies for Net-Zero Data Centers

Room: Garnacha IV

Chair: Jose Luis Friebel, P.E., DatacenterDynamics, Madrid, Spain, Miguel Alava, AWS, Madrid, Spain, Pablo Ruiz Escribano, P.E., Schneider Electric, Madrid, Spain, Patricia Rodriguez, P.E., Microsoft, Madrid, Spain, Ricardo Abad, Affiliate, QUARK, Madrid, Spain and Robert Assink, Digital Realty, Madrid, Spain

Our invited panelists explore pioneering strategies for achieving net-zero carbon emissions in data centers. We debate cutting-edge technologies and innovative designs, addressing the challenge of balancing technological growth with environmental responsibility. Gain insights into collaborative approaches, policy implications and the pivotal role of advancements in steering data centers toward sustainability. Join this crucial conversation at the intersection of technology and environmental stewardship, shaping the future of data centers in the carbon-neutral digital age.

11:00 AM - 12:30 PM

Conference Paper Session 12

Net-Zero Energy Buildings: Policy and Application

Room: Garnacha II and III

Chair:

Zero energy buildings (ZEB) are the magic bullet to decarbonize the buildings sector, but there are many obstacles in the pathway from today's buildings to ZEB. ASHRAE Distinguished Lecturer Samir Traboulsi presents his views on the way forward to a fully ZEB buildings sector. Electrification will play a major role in this energy transition and, after discussing the ZEB issue, the session shall describe how the various countries are handling the emissions associated to electricity, before it is fully carbon free, and how this impacts the calculations of building emissions.

Learning Objectives:

1. Provide an overview of the annual variations of greenhouse gas emissions in the European Union

2. Explain how to calculate greenhouse gas emissions for electricity generation

1. National European Emission Factors for Electricity Generation

Constantinos A Balaras, PhD, Fellow Member¹, Elena Dascalaki, Ph.D., Full Member¹, Matina Patsioti¹, Kalliopi Droutsa, MSc², Simon Kontoyiannidis, MSc¹ and Tomasz Cholewa, Ph.D., P.E.³, (1)Institute for Environmental Research & Sustainable Development, NOA, Athens, Greece, (2)NOA, Athens, Greece, (3)Lublin University of Technology, Lublin, Poland

2. Net Zero Energy Buildings in 2050, Way to Go

Samir R Traboulsi, PhD., P. Eng., Fellow Life Member, Thermotrade/Ranec

11:00 AM - 12:30 PM

Seminar 4 (Intermediate)

The Landscape of Decarbonization and Electrification: New York, Quebec and the UK

Room: Garnacha I

Chair: Samuel Mason, P.Eng., Encompass, Washington, DC

In the global pursuit of mitigating climate change and reducing greenhouse gas emissions, decarbonization and electrification have emerged as paramount strategies. This session explores the multifaceted landscape of decarbonization and electrification within diverse energy contexts, with a particular emphasis on projects unfolding in New York, Quebec and the UK. These regions offer distinct challenges and opportunities, shedding light on the intricate dynamics of transitioning towards cleaner and more sustainable energy systems.

Learning Objectives:

1. Understand the drivers behind grid carbon emissions due to geographic location and resource availability.
2. Explain the limitations to building and grid decarbonization due to geography, building code, and locality.
3. Describe building electrification and decarbonization strategies for residential, mid size and large commercial buildings.
4. Apply decarbonization strategies for peak demand management in buildings.

1. Challenges and Specific Contexts in New York

Samuel C Mason, P.E., BEMP, Full Member¹ and Ed Cremin², (1)Code Green Solutions, Washington, DC, (2)Etude, London, United Kingdom

2. Quebec's Renewable Energy Advantage

Andre Legault, P.Eng., BEMP, Member, MRA, Quebec, QC, Canada

3. Overcoming Peak Demand Challenges

Samuel Mason, PE, Member, Encompass, Washington, DC

Thursday, April 18, 2:00 PM - 3:30 PM

Round Table 6 (Intermediate)

The Future of Energy Is Now

Room: Garnacha II and III

Chair: Francisco Laveron, Iberdrola, Madrid, Spain, Pedro Linares, Universidad Pontificia Comillas, Madrid, Spain, Mikel González-Eguino, University of the Basque Country, Leioa, Spain, Antonio de Juan Fernandez, AFRY Management Consulting, Madrid, Spain and Miriam Bueno, Ministerio para la Transición Ecológica y el Reto Demográfico, Spain

This session describes the current situation of the energy sector, the policies that align security of supply, competitiveness and sustainability, and the sector that we envision for the future. It also reviews: technologies that currently exist, and the ones that we are developing to move from an economy based on fossil fuels to one based on renewable energies; the impact that these profound changes will have on society, aiming at benefiting all, including vulnerable groups; and, finally, the specificities of the Spanish case, one of the countries that are leading the energy transition and can benefit most from it.

2:00 PM - 3:30 PM

Conference Paper Session 13

Strategies and Studies for System Selections, Part 1

Room: Garnacha IV

Chair:

Learning Objectives:

1. Explain the appropriate terminal system based on the type of ground heat exchanger.
2. Evaluate geothermal energy applications in different settings.
3. Describe the future's needs in selecting and operating air handling systems.
4. Define the influence factors of the CO₂ emission caused by air handling systems.

1. The Performance Analysis of Horizontal Mat-Type Ground Heat Exchanger and Vertical Ground Heat Exchanger By Terminal Systems

Sang Ha Leigh, Seoul National University, Seoul, Korea, Republic of (South)

2. Optimizing Air Handling Systems for Minimal CO₂ Footprint: Rethinking Selection and Operation

Martin Lenz, Dipl.-Ing., TROX GmbH, Neukirchen-Vluyn, Germany

2:00 PM - 3:30 PM

Conference Paper Session 14

Community Buildings and Schools: Strategies to Navigate Existing Infrastructure

Room: Garnacha I

Chair:

Decarbonizing the buildings sector requires retrofitting the existing building stock to reach ZEB level or, at least, to substantially reduce their carbon footprint. But the renovation of existing buildings poses significant challenges and, thus, designing the interventions should be carried out taking full advantage of every available opportunity. ASHRAE President-Elect Dennis Knight presents the state of this type of intervention. This presentation shall be followed by the description of two concrete examples of building retrofitting to reduce their carbon footprint.

Learning Objectives:

1. Explain the necessity to emphasize quality outcomes for owners to drive exponential heat pump adoption to decarbonize the built environment.
2. Describe the principal roles and responsibilities of an owners representative for heat pump projects in community institutions.
3. Understand the role of ventilation systems in adaptable buildings.
4. Select the most sustainable ventilation strategy in a flexible context.

1. Essential Lessons from Heat Pump Projects at Congregations and Community Centers

Thomas Yeh, Full Member, Connected Buildings LLC, Webster, NY

2. Unlocking Extensive School Building Usage through Adaptable Ventilation Design: LCA and LCCA

Oskar Seuntjens, Universiteit Antwerpen, Antwerpen, Belgium

3. Integrated Building Design and Building Information Modeling

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

Thursday, April 18, 4:00 PM - 5:00 PM

Round Table 7 (Basic)

What Is Needed to Move Towards Zero Energy and Emission Buildings? Movement to Flexible Codes

Room: Garnacha II and III

Sponsor: TFBD

Chair: Ashley Armstrong, US Department of Energy, Washington, DC, Clay G Nesler, Full Member, The Nesler Group, Fort Meyers, FL, Andrew Warren, British Energy Efficiency Federation, Cambridge, United Kingdom and Bing Liu, PE, Fellow Member, Pacific Northwest National Laboratory, Portland, OR

According to the IEA Net Zero Scenario, all countries need to establish zero carbon-ready building energy codes for both residential and non-residential buildings by 2030. To achieve net zero scenario objectives, all countries will have to implement national building codes, along with enabling policies and programs, that rapidly shift the market towards deep energy efficiency, zero carbon targets, electrification of heating, renewables integration and demand flexibility. This panel engages international building policy experts in a discussion on practical approaches to getting every country on the path to net zero carbon emissions in the built environment.

4:00 PM - 5:00 PM

Conference Paper Session 15

Polymaking for Decarbonization

Room: *Garnacha IV*

Chair:

Polymaking for decarbonization must deal with numerous factors and establish reasonable, fair and effective targets and benchmarking. This session deals with two important aspects for setting decarbonization policies: the first paper discusses the criteria for benchmarking nonresidential buildings into larger or smaller groupings, using a large building sample from South Korea; the second paper addresses the strategies and targets used in various USA local decarbonization programs, for both new and existing buildings, including operational and/or embodied carbon, and its implications in practice. Conclusions may contribute to steer policymakers towards the best solutions for decarbonizing the buildings sector.

Learning Objectives:

1. Explain the need for an appropriate peer group to enable building energy benchmarking while considering the legal building types from a policy perspective.
2. Describe the need to analyze the differences between groups to derive peer groups for building energy benchmarking.
3. Identify typical policies and strategies for achieving net zero carbon for buildings.
4. Apply strategies for their organization to achieve net zero carbon emissions.

1. Method for Identifying the Classification of Similar Building Categories for Energy Benchmarking: EUI Perspective
Hyegi KIM, PhD¹, Sun Sook Kim, Full Member² and Deuk Woo Kim, PhD¹, (1)Korea Institute of Civil Engineering and Building Technology, Goyang, Korea, Republic of (South), (2)Ajou University, Suwon, Korea, Republic of (South)

2. Strategies and Policies for Achieving Net Zero Carbon in the Built Environment: A Comparative Analysis of Operational and Embodied Carbon Approaches

Eddy Santosa, AIA, BEMP, Full Member, Mott MacDonald, Los Angeles, CA

4:00 PM - 5:00 PM

Seminar 5 (Intermediate)

Decarbonizing Cold Climates: Perspectives from Canada

Room: *Garnacha I*

Chair:

Cold climates, like all extreme climates, present particular difficulties for decarbonization. ASHRAE Distinguished Lecturers Erich Binder and Doug Cochrane present strategies and policies from Canada.

1. Industrial Facilities Decarbonization a Canadian Perspective

Erich Binder, Erich Binder Consulting Limited, Calgary, ON, Canada

2. Canada's Latest Decarbonization Efforts Including a Province By Province Breakdown

Doug Cochrane, P.Eng., Independent Consultant, Mississauga, ON, Canada

Friday, April 19

Friday, April 19, 8:00 AM - 9:00 AM

Conference Paper Session 16

Quantifying the Benefits from Single-Family Building Renovations

Room: Garnacha IV

Chair:

Case studies in two different European countries calculate how building renovations can improve building energy performance and facilitate the efforts for decarbonizing the building stock. The first study performs a life cycle assessment of different building renovation scenarios to meet nearly zero energy building and passive house requirements, and provides an insight on how different frameworks can affect the building's energy and environmental performance. The second study examines the environmental impact of a step-by-step renovation measure, considering the renovation sequence, the number of renovation steps and the interval between renovation steps.

Learning Objectives:

1. Describe how different design concepts (nZEB and Passive House) decrease CO2 emissions
2. Explain how different frameworks, such as nZEB and Passive House, affect the building's environmental and energy performance
3. Describe the environmental trade-off between one-step renovation and step-by-step renovation.
4. Describe the importance of planning in the environmental impact of step-by-step renovation.

1. Sustainable Retrofit of Existing Buildings: A Comparative Study between NZEB and Passive House Retrofitting Scenario

Kleoni Ntouvli and Katerina Tsikaloudaki, Dr.Eng, Aristotle University of Thessaloniki, Thessaloniki, Greece

2. The Environmental Impact of Step-By-Step Renovation: A Single-Family Dwelling

Yanaika Decorte, Elke Meiresonne and Marijke Steeman, Ghent University, Ghent, Belgium

8:00 AM - 9:00 AM

Conference Paper Session 17

Strategies for Multi-Family Buildings

Room: Garnacha I

Chair:

Learning Objectives:

1. Define end-users energy profile
2. Design PV layout for small compact roofs to cover shared needs
3. Describe the innovative integrated approach that leverages prefabricated modular design and application of heat pump technology for wastewater heat recovery, production of domestic hot water, and space conditioning to a multi-family high rise building.
4. Explain the importance to incentivize developers and/or building owners to achieve decarbonization goals which are perceived to have significant cost premiums.

2. Data on Household Electricity Consumption in Multi-Apartment Buildings for Optimization of Rooftop PV Systems
Anatolijs Borodinecs, Dr.Ing. and Vladislavs Jacnevs, Riga Technical University, Riga, Latvia

1. A Holistic Approach to Decarbonizing a High-Rise Multi-Family Residential Tower through Design, Construction and Leveraging the Water-Energy Nexus

Aaditya Ajaykumar Patel, Associate¹ and Sergio Sadaba, P.E., BEMP, Full Member², (1)Stantec, Ottawa, ON, Canada, (2)Stantec, Seattle, WA

8:00 AM - 9:00 AM

Seminar 6 (Intermediate)

Impacts of Climate Change and Urbanization on Future Building Performance

Room: Garnacha II and III

Chair: Marianna Vallejo, PhD, Full Member, Jacobs, Athens, Greece

Some words about this session.

1. Impacts of Climate Change and Urbanization on Future Building Performance

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

2. Cooling the Carbon Footprint: HVACR's Crucial Role in ESG Strategies for Sustainable Buildings

Andrea Voigt, Member, Danfoss, Brussels, Belgium

Friday, April 19, 9:10 AM - 10:10 AM

Keynote 3 (Basic)

If Energy Efficiency Is So Wonderful, How Come You Ain't All Mega-Rich?

Room: Garnacha II and III

Chair: Andrew Warren, British Energy Efficiency Federation, Cambridge, United Kingdom

Energy efficiency has officially been designated as the first priority of energy policy, both by the International Energy Agency and by the European Union. Andrew Warren considers the achievements to date that energy efficiency investment has delivered, its agreed delivery targets and potential for the future, and considers what needs to change in order that these priorities continue to be met.

If Energy Efficiency Is So Wonderful, How Come You Ain't All Mega-Rich?

Andrew Warren, British Energy Efficiency Federation, Cambridge, United Kingdom

Friday, April 19, 10:30 AM - 12:00 PM

Conference Paper Session 18

Strategies and Studies for System Selections, Part 2

Room: Garnacha IV

Chair:

Learning Objectives:

1. List the information and databases needed to calculate the life cycle carbon emissions.
2. Explain how to calculate the upfront carbon of a non-residential building in Japan.
3. Explain the importance of the number of air changes to minimize the airborne pathogen infectivity risk.
4. Describe to reduce the HVAC energy consumption and indirect emissions caused by an increased number of air changes.
5. Understand accurate EUI hot water component assessment.
6. Identify opportunities to optimize hot water energy consumption.

1. A Comparative Study of the Whole Life Carbon of a Radiant System and an All-Air System in Japan

Kan Shindo, Student¹ and Shin-ichi Tanabe, Fellow ASHRAE², (1)Waseda University, Tokyo, Japan, (2)Department of Architecture, Waseda University, Tokyo, Japan

2. Airborne Infectivity Control by Proper IAQ while Minimizing Its Environmental Impact

Raul Simonetti, Full Member, CAREL Industries SpA, Brugine, Italy

3. Net Zero Performance Assessment in the United Kingdom: Predicting and Optimizing Dynamic Electric Hot Water Energy Usage

John P Brittle, PhD, Full Member¹ and Mahroo Eftekhari, CEng, Full Member², (1)Crookes Walker Consulting, Leicester, United Kingdom, (2)Loughborough University, Loughborough, United Kingdom

10:30 AM - 12:00 PM
Conference Paper Session 19

Design and Application of a Heat Pump System

Room: Garnacha I

Chair:

Building-level heat pump applications pose challenges for both new and retrofit opportunities. Taking into account the outside of the building, heat pumps must be viable for heating in cold conditions. At the equipment itself, the heat pump may not be sized for peak load, but will be supplemented by gas or electric. Downstream of the heat pump, the infrastructure must be selected to work with the unique characteristics of heat pumps.

Learning Objectives:

1. Describe how a ASHP is able to deliver heating and hot water demand for a flat in a collective edification.
2. Describe how the efficiency of a HP is still twice the one of a gas boiler also under the worst conditions.
3. Describe the energy savings potential for HP boiler system compared to gas boiler system in hydronic heating systems.
4. Explain the life cycle cost effectiveness of the HP boiler design.

1. Filomena Storm Allowed to Test a HP in a Worst-Case Condition for Madrid Weather

Samuel Perez, PhD, Iberdrola, Madrid, Spain

2. Hydronic System Electrification Study: Central Heat Pump Boiler Modeling, Cost Analysis and Policy Considerations

Farhad Farahmand, P.E., TRC, Oakland, CA

10:30 AM - 12:00 PM
Seminar 7 (Intermediate)

Real World Net Zero Strategies for Existing Buildings: Overcoming Challenges and Achieving Sustainable Solutions

Room: Garnacha II and III

Chair: *Stet Allen Sanborn, AIA, Full Member, Smithgroup, Washington, DC*

This practitioner-driven session presents strategies and solutions.

1. How to Move the Embodied Carbon Needle with Procurement

Josh Jacobs, LEED AP+ BD&C, Amazon, Seattle, WA

2. Existing Building Decarbonization Policy and Practices

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

3. Strategies for Decarbonization

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

4. Strategies for Decarbonization: Case Studies

Lourdes Romeo Sus, Batlle i Roig Arquitectura SLP, Barcelona, Spain

Friday, April 19, 12:10 PM - 1:40 PM
Conference Paper Session 20

Life Cycle Assessment of Different Building Construction Materials

Room: Garnacha I

Chair:

Building construction materials influence the overall building environmental performance. Simulations from the use of phase change materials in buildings under different operational conditions and loads in over 30 locations in North America reveal different emission payback periods. The assessment of industrially manufactured walling systems are becoming popular in India as a substitute for conventional construction materials reveal considerably higher embodied emissions that are not compensated by operational savings. Assessing the reforestation potential of different tree species can enhance timber production and use of wood in building construction, along with atmospheric carbon absorption in a wood-friendly city in South Korea.

Learning Objectives:

1. Describe the use of wood to provide ways to decarbonize buildings.
2. Explain optimal tree species for wood applications in buildings.
3. Apply contextualize Life Cycle Assessment Framework with data quality requirements and necessary checks while evaluating life cycle emissions of walling systems

4. Evaluate thermal performances and environmental impacts of the walling systems
5. Explain the potential role of PCMs in shifting conditioning loads and reducing peak electricity use, which is often fossil fuel dominant
6. Describe use of PCMs as a transitional decarbonization technology, and predict locations with the greatest carbon reductions with PCMs

1. Carbon-Neutral Construction: Harnessing Domestic Wood for Sustainability and Community Support

Hyeonwoo Jeong, Eng, Student, Su-Hwan Yeo, Jinyoung Park, Haedeun Park and Seong Jin Chang, PhD, Department of Interior Materials Engineering, College of Construction and Environmental Engineering, Gyeongsang National University, Jinju, Gyeongsangnam-do, Korea, Republic of (South)

2. Embodied Carbon Assessment of Walling Systems Using Life Cycle Approach for Housing Sector in India

Sakshi Nathani, P.E., Student¹, Rajan U Rawal, PhD² and Yashkumar Shukla, Dr.Eng², (1)Shakti Sustainable Energy Foundation, Delhi, India, (2)CEPT University, Ahmedabad, Gujarat, India

3. Operational and Life Cycle Carbon Assessment of Building-Integrated Phase Change Materials

Calene Baylis, PhD, Student and Cynthia A. Cruickshank, Carleton University, Ottawa, ON, Canada

12:10 PM - 1:40 PM

Conference Paper Session 21

How Much Retrofit Is Enough?

Room: Garnacha II and III

Chair: Joseph T Firrantello, Ph.D., P.E., Full Member, McKinstry, Seattle, WA

Renovation to reduce carbon emissions and eventually reach zero carbon may be expensive. Building owners may wish to approach renovation in steps, deciding on how much to do at a particular moment in time. This session discusses criteria to decide how far renovations should go, using different perspectives, namely financial and operational vs. embodied carbon. To conclude, ASHRAE Distinguished Lecturer Esteban Baccini provides lessons learned from his extensive experience, based on concrete case-studies.

Learning Objectives:

1. Describe the trade offs between operational carbon and embodied carbon.
2. Evaluate the needs for retrofits and identify the important parameters in a successful retrofit.

1. Economic/Technical Systems and Equipment Retrofit Analysis and Feasibility

Esteban Baccini, BACCINI HVAC & Energy Efficiency Consulting, Buenos Aires, Argentina

2. Embodied Carbon vs. Operational Carbon: How Much Retrofit Is Enough

Mehdi Ghobadi, Associate, National Research Council Canada, Ottawa, ON, Canada

12:10 PM - 1:40 PM

Conference Paper Session 22

The Benefits of Interconnected Intelligence

Room: Garnacha IV

Chair:

Control of building system operation and interaction let's us work smarter, not harder. These presentations explore interconnected system concepts, rule-based control of thermally activated ceilings, and the use of an AI-powered “assistant” to a facility manager.

Learning Objectives:

1. Describe how to reduce time to value of converged network design.
2. Describe how interoperability creates an ecosystem to maximize efficiencies in the built space.
3. Describe how the large language model powered Intelligent BMS is designed and built.
4. Describe how the interactive AI Agent can help with human operators in building management.
5. Explain demand side management in buildings equipped with TABS.
6. Apply demand-side management strategy based on cost optimization with rule-based control.

1. Delivering an Agile Intelligent Building of the Future

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

2. The Virtual Building Manager: An AI Assistant for Intelligent Building Management Systems

Zeng Peng¹, *Thomas Ohlson Timoudas, PhD*² and *Qian WANG, PhD*³, (1)KTH, Stockholm, Sweden, (2)RISE Research Institutes of Swede, Stockholm, Stockholm, Sweden, (3)KTH, Royal Institute of Technology, Stockholm, Stockholm, Sweden

3. Building-Grid Interaction Analysis of an Office Building with Thermally Activated Ceilings Using Rule Based Control

Tugcin Kirant-Mitic and *Karsten Voss, University of Wuppertal, Wuppertal, Germany*