

A blue-tinted photograph of a mosque with a large central dome and two tall minarets, situated on a waterfront at night. The city lights and the water's reflection are visible.

ASHRAE Global HVAC&R Summit
Istanbul 2022

**Securing Our Future:
Addressing the
Critical Issues of the Day**

ASHRAE HVAC&R Global Summit Final Report

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Acknowledgments

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This final report was written by a collaborative effort of the three co-coordinators, along with input from each topic’s moderator and recorder (listed in the heading for each topic). Special thanks goes out to Cindy Michaels, ASHRAE Staff, for providing the final editing.

Introduction

The ASHRAE Global HVAC&R Summit is a key element of ASHRAE President Farooq Mehboob’s vision for “Securing Our Future,” the Society’s theme for 2022–2023. President Mehboob’s vision contains several pillars to support this theme, including “Harnessing the Power of Relationships” and “Harvesting Information in the Service of our Members,” both of which are woven into the fabric of the Summit. President Mehboob is also intent on raising the profile of the HVAC&R industry, a barrier all of us face that contradicts the importance of our work as we strive to address our common critical issues and serve humanity.

Concept

The ASHRAE Global HVAC&R Summit was designed to create an environment of collaboration and strategic dialogue to address six critical issues of the day. The delegates to the Summit were specifically selected to represent every segment of our industry, every geographical area of the globe, and every economic condition. Through this diverse assembly we created a consensus-based environment allowing us to talk with one voice in a forward-thinking manner. The ultimate goal of the Summit was to develop an action plan we all can endorse, thereby making our planet a better place for all.

Format

The Summit began with an international survey developed and distributed by the ASHRAE Associate Society Alliance (AASA). In the survey, respondents were asked to list their top critical issues of the day. The response to the survey was excellent and revealed, a strong consensus regardless of geographical location. The six critical issues of the day identified by the survey are:

- Decarbonization
- IEQ/Wellness
- Climate Crisis Mitigation
- Food Security—The Cold Chain
- Energy Security
- Workforce Development

The next step in forming the Summit was to determine how best to create a diverse population of strategic thinkers and place them in an environment that facilitated collaboration, dialogue, and trust. After much debate, it was decided that to optimize the environment, the Summit was to be invitation only. The invitation-only mechanism was new to ASHRAE, which had previously gone to great lengths to ensure that its conferences, meetings, seminars, and other events were open to all. However, the advantages of using an invitation-only process were compelling:

- Diversity could be ensured by carefully selecting the delegates to the Summit. This aligned well with President Mehboob’s desire to promote diversity, and particularly diversity of thought, within the Society.
- Small group discussions would be possible. Such discussions can fuel a strategic discussion of the assembly as a whole. Inasmuch as six critical issues of the day had been identified, it was decided to create six small discussion teams, one for each topic.
- The attendance numbers could remain at a number low enough to result in meaningful dialogue and outcomes. Research indicates that the optimal size for a strategic discussion is between 10 and 15 people. Therefore, a target of 10 to 13 people per topic team was produced, giving the Summit a population of 60 to 72 invited delegates.
- Limiting the Summit participants to invited delegates only and further selecting only six critical issues meant that the Summit could be completed in two days, an important consideration given that the strategic positions held by the delegates, keynote speakers and moderators would likely not allow for more than a two-day summit.

Once the number of delegates was determined, selecting the actual delegates became the next step and one of the most difficult. In keeping with the Summit principles of diversity and strategic thinking, a master list of desired delegates was generated, focusing on individuals that had the ability to provide the high-level, strategic perspective needed by the Summit. This list included senior leaders from manufacturing, consulting engineering, architecture, and contracting as well as policy makers. Invitation letters were sent out. Once again, the response was outstanding, indicating the need perceived by the industry for a strategic, forward-thinking discussion on the critical issues of the day. A complete listing of the 72 delegates who attended the Summit is available in [Appendix A](#) and demonstrates the large number of CEOs, presidents, Secretary Generals, and other leaders from countries all over the world.

In addition to limiting the number of delegates “at the table” to discuss the critical issues of the day, it was hoped that interested attendees would also attend the Summit, listen to the

discussions by the six teams in breakout sessions, and participate in the general assembly. Therefore, the venue for the Summit was also an important consideration. Fortunately, ASHRAE's Region-at-Large (RAL) graciously volunteered to sponsor the Summit at their Chapter Regional Conference (CRC), held October 12, 13 and 14, 2022, in Istanbul, Turkey. The total attendance of the delegates and interested attendees at the Summit was 140, which considerably exceeded the attendance targets.

To provide a consensus-based outcome, the Summit format called for six prominent, globally recognized keynote speakers, one on each topic, to address the entire assembly. The keynote addresses were brief, twenty minutes each, and highlighted the issues we face today on each topic. The slide presentations of the keynote addresses can be found at the first bookmark in Appendices B–G.

After all the keynote addresses were given, the delegates, who had been assigned to topic teams based on their preferences, retired to their topics' rooms for the first breakout session. There were two breakout sessions per topic throughout the course of the Summit. The discussions in the breakout sessions were each led by a carefully selected and trained moderator. Additionally, a recorder was assigned to each breakout session to take notes and assist the moderator in preparing a report to the entire assembly. The recorders at the Summit were ASHRAE staff directors. The keynote speakers were invited to sit in on the breakout sessions to serve as resources for the topic areas.

The first breakout session called for the delegates to reach a consensus on defining the issues and their likely causes. After this discussion, each team reported to the assembly as a whole. The second breakout session called for the delegates to reach a consensus on an action plan we can take as an industry to address the critical issues of each topic. After the second breakout session, each topic team again reported to the assembly as a whole to forge a consensus of the assembly on that action plan. One unique tool that was used to help forge a consensus during the Summit was Menti, an online survey tool that allowed the whole assembly to weigh in with their perspectives and opinions in real time and for the survey results to be available and

displayed immediately. The final team reports on each topic, which were presented to the whole assembly during the Summit, are provided in the following sections. These reports include some of the Menti survey results obtained in the discussions among the whole assembly. The full Menti survey results for each topic can be found at the fourth bookmark in Appendices B–G.

Decarbonization

Keynote Speaker: Luke Leung—Principal, Skidmore, Owings and Merrill, LLC

Moderator: Mikael Borjesson—Director, Competence, Sustainability, and External Relations, Swegon

Recorder: Alice Yates—Director of Government Affairs, ASHRAE

The Importance of Decarbonization

The Decarbonization keynote address and first breakout session both focused on the importance of the built environment on decarbonization, examining population and building growth projections, the relevance of the carbon intensity of the electric grid, and the importance of addressing both operational and embodied carbon. The well-known fact that our population is expanding and projected to reach nearly 10 billion people globally by 2050¹ is one driver of the carbon problem. The global migration of the population to cities will result in the building floor area doubling by 2060. Inasmuch as buildings contribute around 39% of all carbon emissions into the atmosphere, the expanding carbon problem is clear, as is the importance of the building industry.

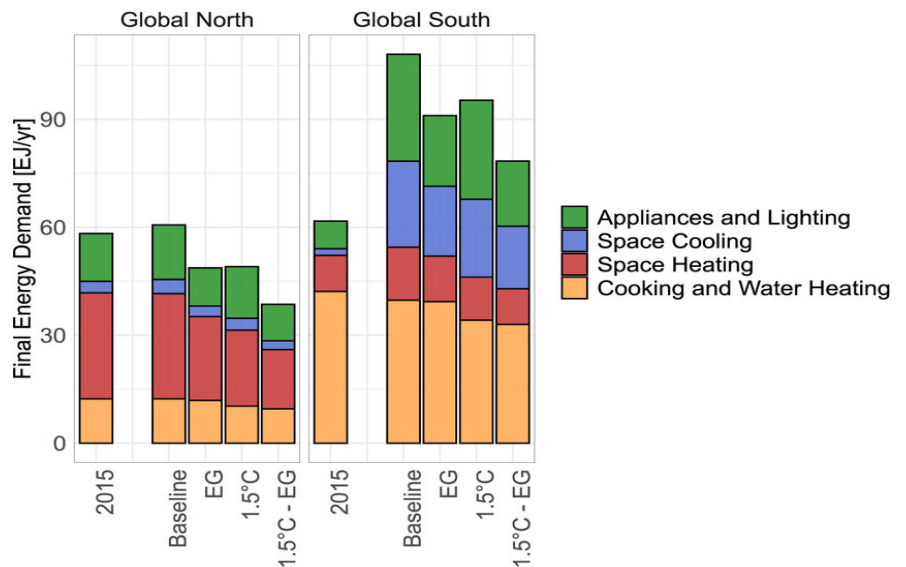
Defining the Issues

The global energy demand for 2015 was compared to the projected global energy demand for 2050 and was segregated into Global North and Global South geographies. These data revealed significant differences in energy use in each geography and imply that different strategies will

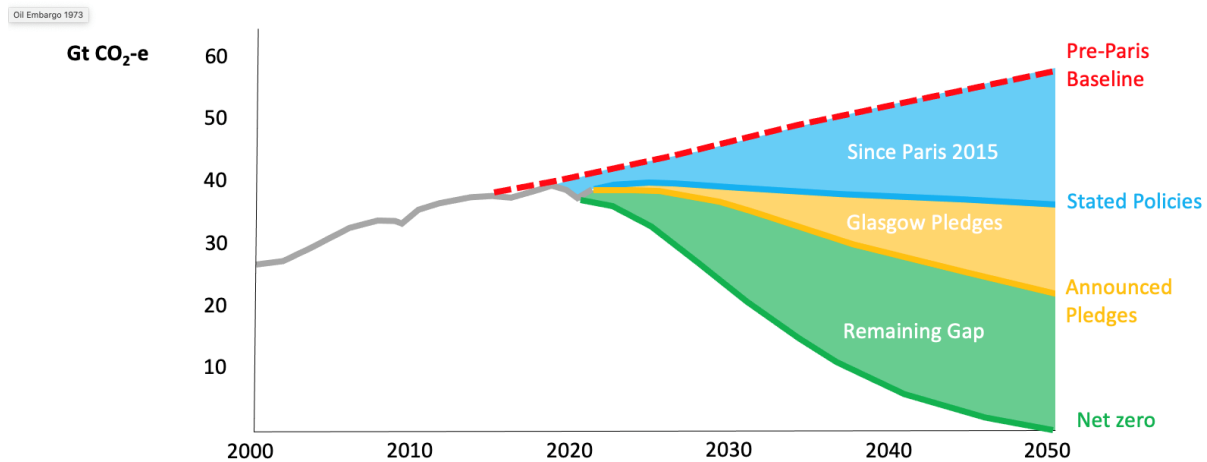
¹ United Nations Population Projections, 2022, <https://population.un.org/wpp/>

be required to result in decarbonization for the Global North and Global South. The various Menti responses confirmed this observation.

Despite a unified effort to address decarbonization globally, Earth's temperature continues to climb, resulting in a rapidly changing climate. It is estimated that Earth's temperature will reach the Paris Accord's target maximum of 1.5°C by 2040.²



Exacerbating this situation is the fact that our world is facing a significant gap in reaching Net Zero Carbon goals by 2050:



Credit: <https://carbontracker.org/>

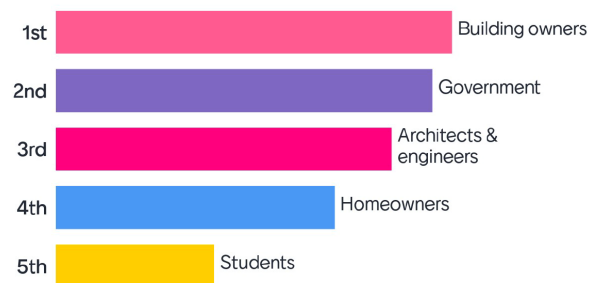
The urgency of the situation is unmistakable. Fortunately, the built environment is in a strong position to positively impact the decarbonization effort because of the large percentage of carbon emissions attributable to buildings. The whole-life carbon distribution for an average

² "Analysis: When might the world exceed 1.5C and 2C of global warming?," Carbon Brief, 2020, <https://www.carbonbrief.org/analysis-when-might-the-world-exceed-1-5c-and-2c-of-global-warming/>

commercial building, based on a global average electric grid (0.475 kg CO₂/KWh, 1.045 lb CO₂/KWh), is approximately 90% operational carbon, 4% embodied carbon for mechanical, electrical and plumbing (MEP) and 6% embodied carbon for other than MEP. The ratio of operational to embedded carbon varies considerably based on grid carbon emissions. For example, in a cleaner grid (0.167 kg CO₂/KWh, 0.367 lb CO₂/KWh) the operational emissions in an average commercial building drop to 75% while the MEP embodied carbon increases to 10%, with all other embedded carbon rising to 15%. These data point to the importance of current efforts to track the impact of embodied carbon across the whole life of a building (from product stage to end-of-life stage) using a Life-Cycle Analysis (LCA) coupled with an Environmental Product Declaration (EPD). From these data, benchmarks for embodied carbon LCA intensity can be developed to help drive down the impact of embodied carbon and get us closer to our Net Zero Carbon goal. The “circular economy” concept completes the loop by focusing on reuse, recovery, and recycling potential.

Based on this preliminary discussion, the assembly identified the most important target audience to reach as building owners—not a surprising conclusion. Government was the second highest rated target audience, a result that echoes through many of the recommended actions described below.

The most important target audience to reach regarding decarbonization is



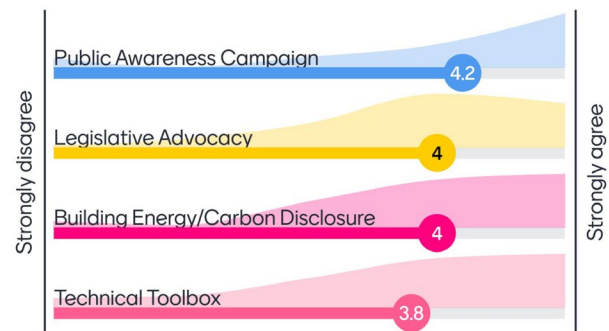
Call to Action Plan

In the second Decarbonization breakout session, the team proposed four action plans:

- Public Awareness Campaign
- Legislative Advocacy
- Building Energy/Carbon Disclosure
- Technical Toolbox

A Menti question was posed to the assembly, asking them to rank these actions from highest priority to lowest. The assembly felt that a public awareness campaign was the highest priority and presumably would produce the greatest impact, followed closely by legislative advocacy.

Do you agree with the actions we propose?

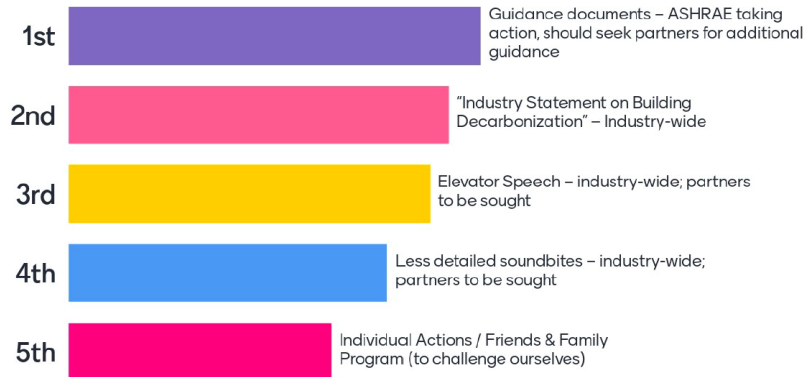


The **Public Awareness Campaign** was broken down into the following categories based on immediacy:

- Immediate actions
 - Communications resources
 - Public Policy Issue Brief (PPIB) **Completed**
 - Less-detailed soundbites—industry-wide; partners to be sought
 - Elevator speech—industry-wide; partners to be sought
- Short-term actions
 - Individual actions/friends and family program (to challenge ourselves)
- Medium-term actions
 - Industry statement on building decarbonization—industry-wide
 - To include soundbites and elevator speech
 - Guidance documents—ASHRAE taking actions through its Task Force for Building Decarbonization (TFBD); should seek partners for additional guidance documents and tools

Of these recommended actions, the assembly felt that guidance documents, a medium-term action, had the highest priority.

Rank public awareness campaign proposed actions



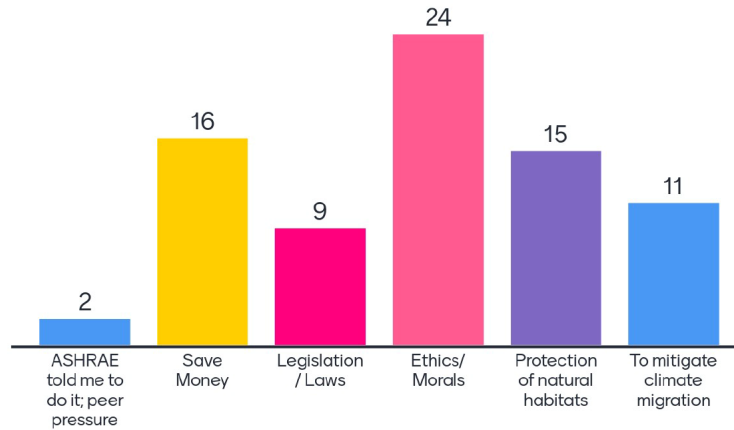
Legislative Advocacy was the second action plan recommended by the Decarbonization team.

Again, the action plan was similarly developed based on the immediacy of the action:

- Immediate actions
 - Industry letter to governments (pre-COP27 opportunity): buildings matter to our planet—signed by multiple associations on a global basis **Completed and delivered to COP27 participants**
- Medium-term actions
 - Define unified/global goal(s) for building decarbonization
 - Mandatory energy/carbon labeling of buildings
 - Building performance standards (policy requirements): voluntary/mandatory
 - Simplified decarbonization (design) standards for buildings
 - New buildings
 - Existing buildings: deep retrofits

Even though legislative advocacy was the second highest rated priority according to the Decarbonization team, an interesting Menti question produced a much different position by the assembly, who rated legislation/laws as the fifth highest driver to decarbonizing, just above peer pressure. This Menti response indicates that ethics and money (two divergent motivators) would likely be more effective in driving Summit attendees to decarbonize than legislation/laws. A survey of the broader population may reveal different results.

What would drive you to decarbonize?



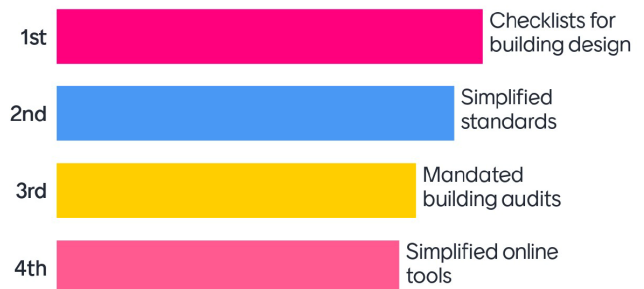
Building Energy/Carbon Disclosure was the third highest priority identified by the assembly, who recommended the following actions to implement the plan. There is considerable overlap between these actions and the actions recommended for the Public Awareness campaign and the Legislative Advocacy plan.

- Communication tool: so that the public can understand the connection between buildings, energy use, expenditures and climate change; needs to have a simple label
- Possible legislative proposals (e.g., mandatory requirements; time-of-day tariffs)
- This is the time to do it; demonstrate that it is possible
- Challenge ourselves: can take a lot of time to develop and implement
- Solution: **keep it simple and usable**—we can make this happen!

Again, responses to a Menti question to the assembly lend some insight on the topic of building energy/carbon disclosure, which would include auditing. The Menti question specifically

identifies actions that are likely to be of the most value in a developing economy; mandated building audits was not as well received as checklists and simplified standards. It may be that mandated building audits may be more highly regarded in a

Which of the following is likely to be of the most value in decarbonization in a developing economy



developed economy—a differentiation that aligns with the previous discussion about Global North and Global South designations.

Creating a **Technical Toolbox** was the final recommendation of the Decarbonization team. The highest priority within this recommendation is the creation of checklists that are “location-specific,” a theme repeated in the other recommendations. As noted in the previous Menti question, the use of checklists was the highest rated action likely to be of the most value in developing economies, along with simplified standards. The location-specific checklists (on topics such as avoiding combustion, using passive measures, using low-GWP refrigerants, and equipment/technology options) recommended by the Decarbonization team include the following:

- Design/operational
- Ownership/looking to purchase or rent (e.g., What is the energy use/source? Choice of appliances, Interior design, architectural elements.)
- Residential
- Commercial
- Educational facilities
- Health-care facilities
- Institutional owners

Summary

The Decarbonization team, as did the other teams, expressed a great deal of urgency in dealing with the problem of decarbonization. They also highlighted the point that no one organization can address the issue alone. It will take all of us working collaboratively to decarbonize the built environment in order to protect our environment. At the same time, the team struck a note of optimism, convinced that together we can make a difference. The example of our success in reducing the decay of ozone in our atmosphere, as outlined by the Montreal Protocol action plan, was used as a prime example of what is possible.

The keynote address slide presentation, the report after the first breakout session, the report after the second breakout session, and the full Menti survey results for the Decarbonization topic can be found at the relevant bookmarks of [Appendix B](#).

IEQ/Wellness

Keynote Speaker: Pawel Wargocki—Associate Professor, International Centre for Indoor Environment and Energy, Technical University of Denmark

Moderator: Bill Bahnfleth—Vice-President, IEQ Global Alliance

Recorder: Joyce Abrams—Director of Member Services, ASHRAE

The Importance of IEQ/Wellness

Indoor environmental quality (IEQ) includes the influence on occupants of four major physical factors in the indoor environment:

- Thermal comfort (temperature, thermal radiation, humidity, air velocity)
- Indoor air quality (particulate matter, chemicals, humidity)
- Lighting (artificial light, daylight, circadian rhythms)
- Acoustic (system noise, outside noise, vibrations)

These factors influence people’s health, comfort, wellness, and productivity individually and collectively. When discussing health, it is important to remember the World Health Organization (WHO) definition of health, which notes that health is “not merely the absence of disease or infirmity” but extends to other physical, mental, and social dimensions of life.

Defining the Issues

The IEQ/Wellness keynote address and first breakout session both focused on the importance of IEQ in the built environment. As illustrated in the following figure, we spend about 90% of our time indoors in buildings or during transportation. The majority of the time we spend in our home includes about 1/3 of the day in bedrooms. This clearly shows the importance of a healthy indoor environment. The figure also illustrates that during a day the intake of food

- Codes/standards/certification
 - Lack of building codes and standards
 - Need for certifications, rating, measurable metrics, air cleaner data
- Policy
 - Need for legislation, accountability
 - Lack of code enforcement

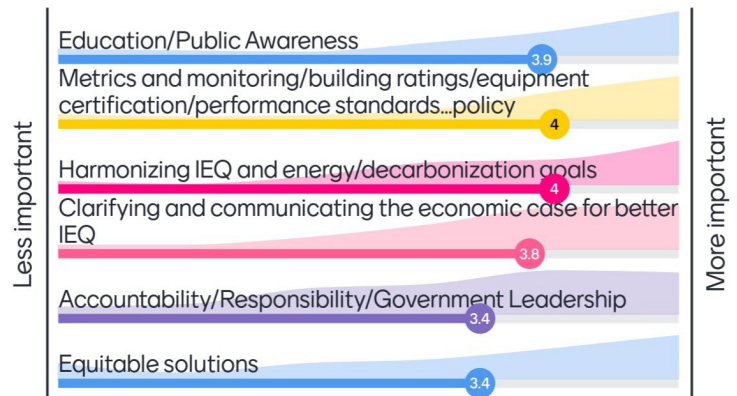
Call to Action Plan

In the second IEQ/Wellness breakout session, the team developed six action plans:

- Education/Public Awareness
- Metrics and Monitoring/Building and Equipment Ratings
- Harmonizing IEQ and Energy/Decarbonization Goals
- Clarifying and Communicating Economic Cases for Better IEQ
- Accountability/Responsibility/Government Leadership
- Equitable Solutions

The assembly as a whole was asked to evaluate how important the proposed actions are and the likelihood that the workplan for each item would succeed as proposed. The Menti survey results show that the assembly felt that public awareness, metrics, and harmonizing IEQ/Energy were the most important issues and had the highest chance to succeed, but none were unimportant.

The objective of the **Education/Public Awareness** plan is to develop and disseminate necessary and appropriate information to target audiences/stakeholders (e.g., investors,



owners, operators, government/code officials/policy makers, the general public, and those in design and construction). The steps to this plan include the following:

- Identify distinct groups that need information
- Identify level of detail by group
- Understand each group's priority list
- Define subject matter and preferred communication channel/assess knowledge and priorities
- Develop and disseminate material
- Evaluate impact of education/training/information

The timeline for this plan is immediate and up to two years for some stakeholders, depending on existing knowledge and frameworks.

The objective of the **Metrics and Monitoring/Building and Equipment Ratings** plan is two-fold: to develop and implement metrics that can support building IEQ ratings and to develop and implement metrics that can support equipment ratings. The steps to this plan include the following:

- Building IEQ ratings for design and operation
 - Identify market for each rating program
 - Develop and harmonize practical, measurable building metrics
 - Develop building IEQ rating system and/or standards, which would require monitoring
 - Develop reporting structure to achieve certification
 - Pilot a program to ensure program is implementable
 - Create implementation plan
- equipment ratings
 - Determine what new standards are needed
 - Develop method of test standards that support building IEQ ratings
 - Collaborate with product certification organizations to develop new certifications, if needed

The timeline for this plan is 18 months to 3 years for development of the metrics that can support building IEQ ratings and 3 years for development of the metrics that can support equipment ratings.

The objective of the **Harmonizing IEQ and Energy/Decarbonization Goals** plan is to identify ways to achieve better IEQ while achieving decarbonization goals. The steps to this plan include the following:

- Establish criteria for minimum acceptable IEQ
- Reset energy/decarbonization benchmarks that combine IEQ and carbon
- Develop a tool for comparison of IEQ and energy for use by designer, owner, and operator
- Develop technical solutions that make achieving goals of both factors possible, based on work done for the metrics and monitoring/building and equipment ratings plan

The timeline for this plan is one to two years for developing the framework; resetting benchmarks is dependent on completion of the ratings system for the Metrics and Monitoring/Building and Equipment Ratings plan.

The objective of the **Clarifying and communicating economic case for better IEQ** is to explain the evidence for better IEQ to make it understandable by key stakeholders. The steps of this plan are the following:

- Compile available evidence (e.g., productivity, direct healthcare costs)
- Identify stakeholders and their economic objectives
- Identify relevant cost and benefit factors
- Develop an easy-to-use tool for owners and/or operators to determine economic performance of improving IEQ to drive behavior

The timeline for this plan is one to two years.

The objective of the **Accountability/ Responsibility/Government Leadership** plan is to promote effective levels of regulation of IEQ. The steps of this plan are the following:

- Advocate mandatory IEQ building design and operation
- Identify authorities
- Identify collaborators

The timeline for this plan can begin immediately and continue indefinitely.

The objective of the **Equitable Solutions** plan is to ensure tools and documents from all of the above plans can be used to improve IEQ in all socioeconomic conditions, demographic groups and locations. The steps of this plan are the following:

- Identify barriers to improving IEQ
- Create oversight groups of representatives
- Create documentation for best practices and feasible local solutions

The timeline for this plan can begin immediately and continue indefinitely.

Summary

According to the IEQ/Wellness team, these plans should be considered drafts for further development. Some actions have an end point, whereas others are ongoing.

In general, consensus formed around a need to establish IEQ metrics and recommendations for an IEQ certification in addition to an energy certification. The team also believes that looking at the combined influence of the IEQ factors is critical to meaningful advancement of IEQ and wellness in buildings.

The keynote address slide presentation, the report after the first breakout session, the report after the second breakout session, and the full Menti survey results for the IEQ/Wellness topic can be found at the relevant bookmarks of [Appendix C](#).

Food Security—The Cold Chain

Keynote Speaker: Judith Evans—Professor, London South Bank University

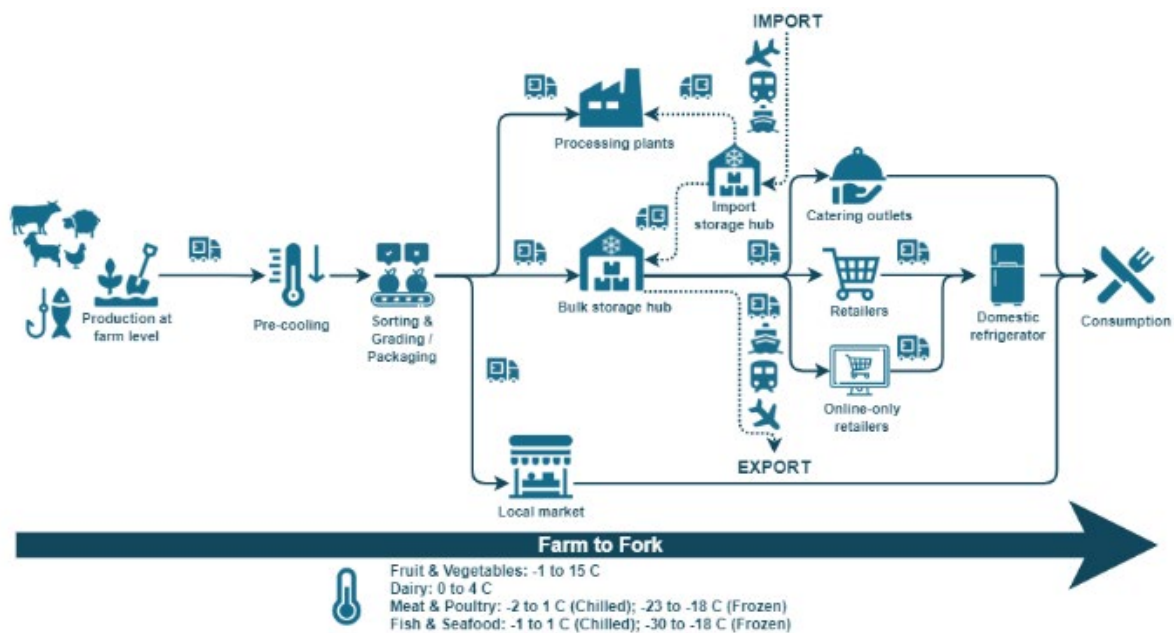
Moderators: Mike Creamer—President, Institute of Refrigeration
Didier Coulomb—Director General, International Institute of Refrigeration

Recorder: Vanita Gupta—Director of Marketing, ASHRAE

The Importance of Food Security—The Cold Chain

Food security is critical to the well-being of humanity. A good definition of food security is “when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (1996 World Food Summit). Agribusiness, which includes food, is the largest industry in the world. It is worth \$5.8 trillion USD and growing at a rate of 9.7%. The food agribusiness sector represents approximately 4% of the GDP in a developed economy and can be as high as 60% in developing countries.

The journey from farm to fork is long and complex, covering multiple business sectors. The cold chain plays a critical role at several key points along this chain. It includes both fixed spaces (storage, retail, consumer) and mobile (ship, truck, rail etc).



Copyright Centre for Sustainable Cooling

The cold chain is the place where the HVAC&R industry can add the most value. It is more than just the technology; issues around the cold chain should include, among other things, the following:

- Energy resources
- Behavior changes
- Skills and capacity building
- Business models and finance
- IT and trading platforms
- Infrastructure
- Policy

Defining the Issues

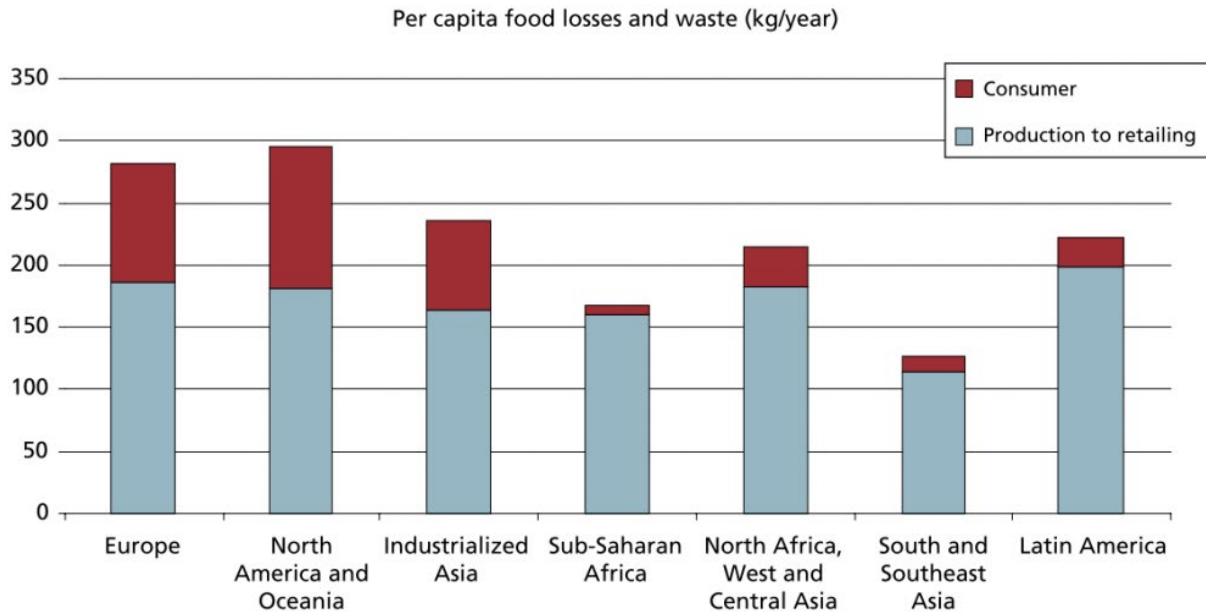
Providing food security is a large and complex topic. The Food Security—The Cold Chain team focused on the cold chain, its role in food security and the role our industry can play in improving the cold chain. They developed the following major issues for this topic:

- Food loss
- Food waste
- Health (vaccines)
- Climate impact on food production
- Impact on climate due to food and agribusiness

The International Institute of Refrigeration (IIR) estimates that 778 million tons out of the potential 1,661 million tons of food is preserved by refrigeration in the world. This leads to a 13% (>475 million tons) loss of food due to a lack of refrigeration. That is enough to feed almost 1 billion people. The losses are more severe in developing economies. For example, 37% of all food is lost in sub-Saharan Africa.

In addition to food loss, WHO estimates that 1 in 10 people contract foodborne diseases from spoiled food. This in turns leads to 420,000 deaths, and 125,000 of those are children.

Food waste occurs where food is successfully delivered to the consumer but is not used in time. In developed countries this can be as high as 30% of the country's total food. In the United Kingdom alone, this amounts to 6.7 million tons of food, of which 50% could be eaten.



Credit: IIR, *The Role of Refrigeration in Worldwide Nutrition: 6th Informatory Note on Refrigeration and Food* (2020), <https://iifiir.org/en/fridoc/the-role-of-refrigeration-in-worldwide-nutrition-2020-142029>

Food waste is not just a missed opportunity—the effort to produce that food impacted natural resources such as water and land. And food waste releases 2 gigatons CO₂/yr from production and another 2.4 gigatons CO₂/yr from the food itself.³

Vaccines and medicines can be temperature sensitive. In low-income countries (LICs), 25% of vaccines reach their destination with degraded efficacy mainly due to failures in the cold chain. Traditionally vaccines require 2°C to –8°C temperatures, but now there is often a need for –80°C conditions, which is a technical challenge even in developed countries.

Climate change is impacting food production through severe weather drought, flooding, etc. and effecting where food can be grown, thus increasing the need for the cold chain.

Food production and the supply chain represent around 30% of global energy. The food system (agriculture + land use, storage, transport, packaging, processing, and retail consumption) is

³ UNEP, Briefing Note: Sustainable Cold Chain and Food Loss Reduction, 2019, https://ozone.unep.org/system/files/documents/MOP31-HL_Briefing_Note.pdf

attributable for 21% to 37% of total greenhouse gas (GHG) emissions. The emissions⁴ from the global cold chain alone are 1,265 million tons CO_{2eq}. Additionally, most refrigerants used in the cold chain are GHGs.

Call to Action Plan

The Food Security—The Cold Chain team proposed three action plans:

- Increase Cold Chain Competency Globally to Make it More Available Where Required
- Advance Low-Energy and Low-Carbon Cold Chain Technologies
- Advance Low-GWP Refrigerants

The **Increase Cold Chain Competency Globally to Make it More Available Where Required** plan calls for streamlined cooperation between organizations such as Global Cold Chain Alliance (GCCA), United Nations (UN), International Institute of Refrigeration (IIR), ASHRAE, and ASHRAE Associate Society Alliance (AASA) members active in the cold chain.

The plan indicates that these organizations should:

- Create a channel that puts their technical, advocacy and education assets in direct and streamlined contact with each other
- Share best practices and deploy cold chain technology covering design, construction, maintenance, and operation of cold chain systems
- Not reinvent the wheel, but use the best technology from whichever organization has it
- Target LICs, selecting and packaging the best technology that can be practically applied in these locations
- Consider a cold chain summit to expedite the gathering of cold chain knowledge for rapid deployment

The **Advance Low-Energy and Low-Carbon Cold Chain Technologies** plan calls for ASHRAE and AASA organizations to work with the industry and identify knowledge gaps that these organizations can fill, coordinate their programs to address these knowledge gaps, and work

⁴ IIR, *The Carbon Footprint of the Cold Chain: 7th Informatory Note on Refrigeration and Food*, 2021, <https://iifiir.org/en/fridoc/the-carbon-footprint-of-the-cold-chain-7-lt-sup-gt-th-lt-sup-gt-informatory-143457>

together to fund (or get funding for) research. There should also be collaboration with the United Nations and other organizations to move the most practical technology to LIC countries.

The **Advance Low-GWP Refrigerants** plan calls for the industry to identify the barriers to rapid adoption of new low global warming potential (GWP) refrigerants; develop programs to address barriers, particularly in open market technology such as piping system design and advocacy with regional and federal policy makers, and speak with a common voice amongst organizations and industries in these conversations; and develop training for designers, contractors, operators, and maintenance staff on the proper and safe use of new refrigerants.

Summary

The cold chain is the place where the HVAC&R industry can add the most value and thereby produce the most tangible results in addressing food security issues. Therefore, the Food Security—The Cold Chain team focused on the cold chain aspect of food security, even though the topic as a whole is very large and complex.

In general, a consensus formed around the need to establish a global competency in cold chain technology in order to make it more accessible worldwide. This will take a concerted effort by a number of collaborating organizations operating in concert. Further, there is a critical need to expand the knowledge and expertise in advanced low-energy, low-carbon cold-chain technologies. Here again, this will be a team effort involving a number of HVAC&R and related organizations. Finally, there is a consensus to advance low-GWP refrigerants by addressing the barriers that are inhibiting their implementation. It will be necessary for the HVAC&R industry to come together to create the educational and training products needed by building owners and their maintenance staff to implement low-GWP refrigerants.

The keynote address slide presentation, the report after the first breakout session, the report after the second breakout session, and the full Menti survey results for the Food Security—The Cold Chain topic can be found at the relevant bookmarks of [Appendix D](#).

Climate Crisis Mitigation

Keynote Speaker: Dru Crawley—Fellow and Director, Building Performance Research

Moderator: Ashish Rakheja—Vice-President, ASHRAE

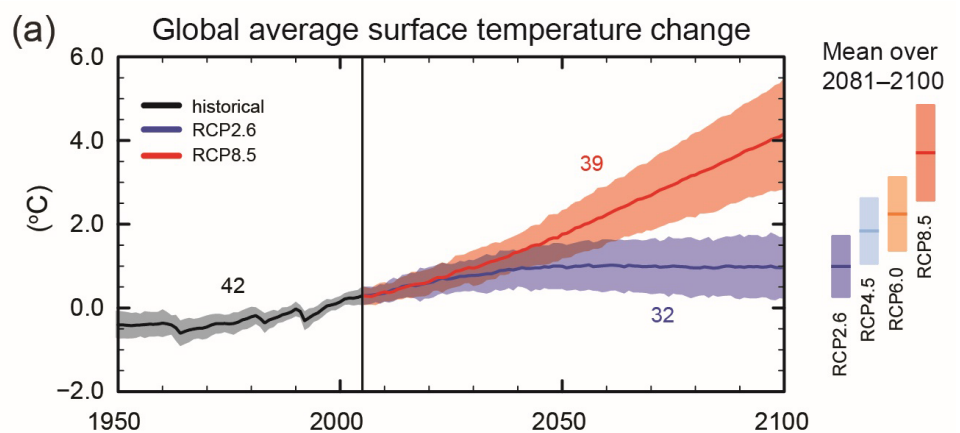
Recorder: Stephanie Reiniche—Director of Technology, ASHRAE

The Importance of Climate Crisis Mitigation

The United Nations is predicting the world population will grow by 26% in the next 30 years⁵ and that much of that growth will come from the developing world. To meet the growing urbanization trend, the built environment footprint will grow by nearly 230 billion m² (2.4 trillion ft²). This is the equivalent of constructing an entire New York City every 34 days.⁶ This exponential rise in construction will add to the climate crisis challenge faced by planet Earth.

Defining the Issues

The release of greenhouse gases (GHGs) is increasing the global temperature. The hottest five years on record have occurred since 2016, and 2022 looks like will make it to the list of the top three warmest years. At the Conference of the Parties 26



Credit: Intergovernmental Panel on Climate Change (IPCC)

⁵ United Nations, “Global Issues: Population,” <https://www.un.org/en/global-issues/population>

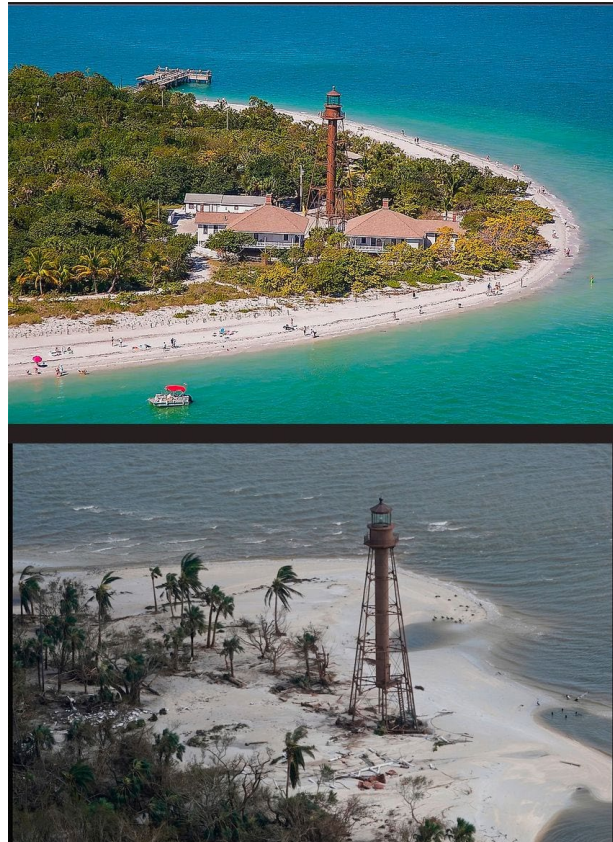
⁶ Architecture 2030, “Why the Built Environment?,” <https://architecture2030.org/why-the-building-sector/>

(COP26), the United Nations Environment Programme (UNEP) reported that climate change has already occurred, and some impacts may not be reversible. Thus, the goal of limiting the global temperature rise to 1.5°C (2.7°F) by the end of this century is becoming increasingly difficult.

A consequence of the climate crisis is more extreme weather patterns. As a result, increase in frequency of hurricanes, tornados, floods, melting of the permafrost, forest fires, etc., is testing the resilience of buildings.

The built environment is a major contributor to climate change. The operational energy to run buildings releases nearly 37% of global CO₂ emissions (the most abundant greenhouse gas). In addition, embodied carbon from building construction is also emerging as a major issue.

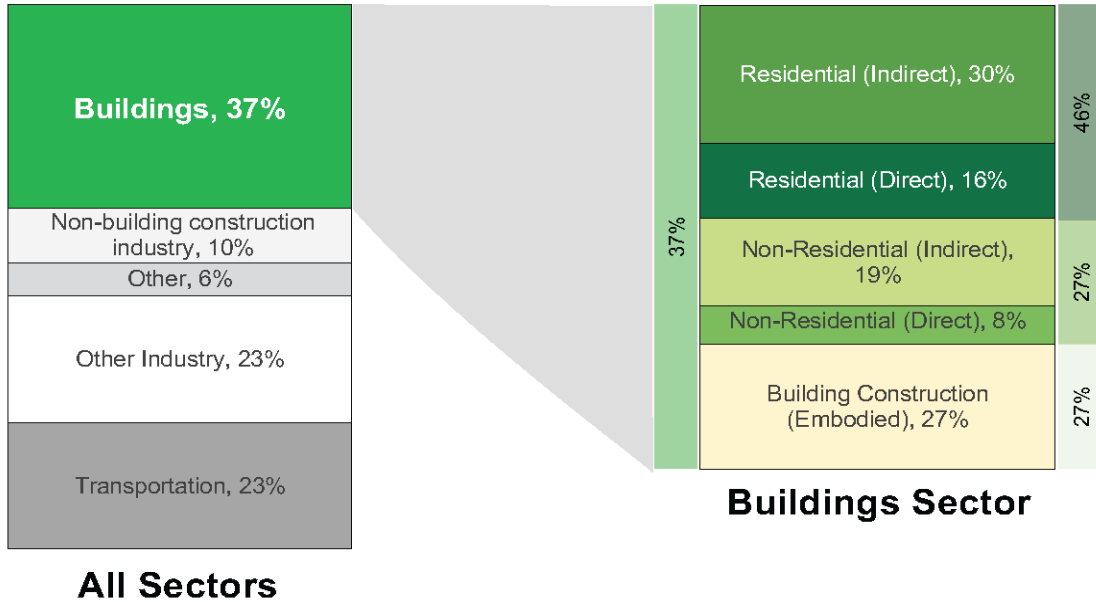
The climate crisis and global climate change is likely to impact design conditions for buildings. Heating requirements may go down significantly, while cooling loads will increase 50% to 200% depending on location. There will be a rise in nighttime temperatures. The combined impact will create an increase in the energy demand of buildings, which further aggravates their climate footprint.



Impact of Recent Hurricane in Sanibel, Florida

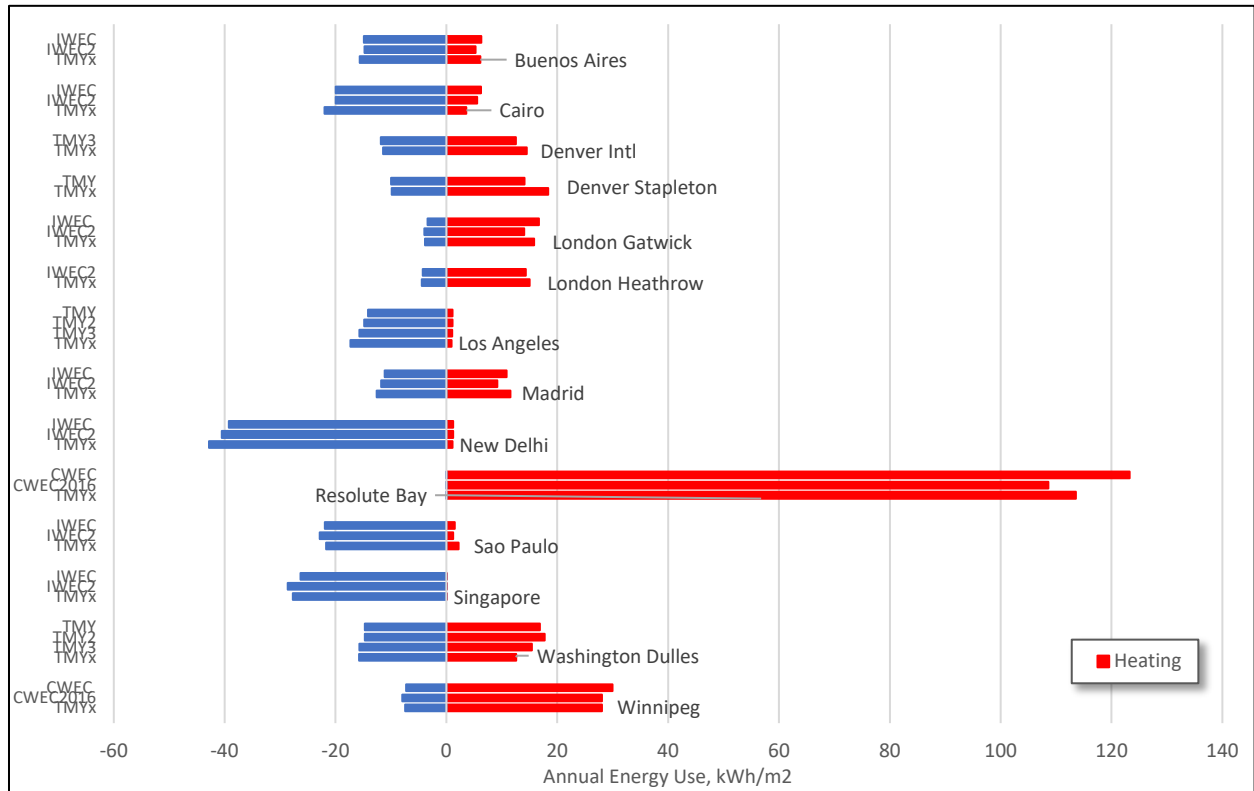
Credit:

<https://mobile.twitter.com/LHDirectory/status/1576193500655206401>



Credit: IEA, "Global energy use and energy-related CO2 emissions by sector, 2020,"

<https://www.iea.org/data-and-statistics/charts/global-energy-use-and-energy-related-co2-emissions-by-sector-2020>



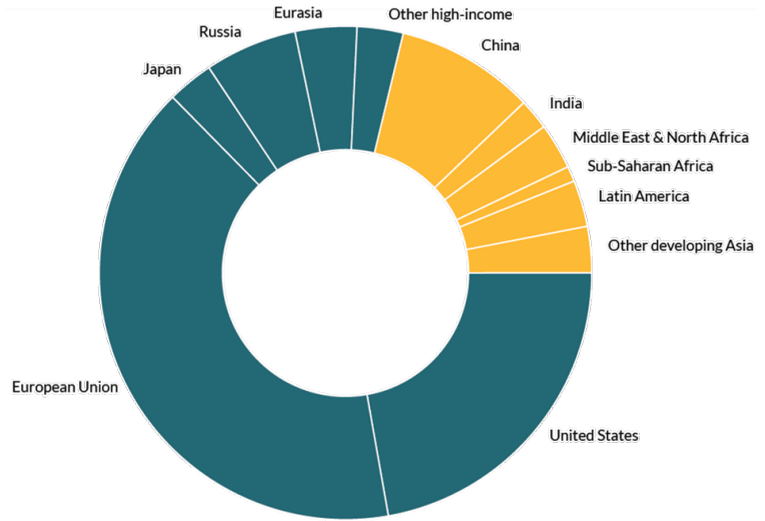
Credit: Drury B. Crawley and Linda K. Lawrie (2021), "Our Climate Conditions Are Already Changing—Should We Care?," *Building Services Engineering Research and Technology*, 42(5):507–16

The effects of the climate crisis are not evenly felt. For example, the polar regions are witnessing a greater impact from global warming. Additionally, the countries that have historically contributed the greatest to climate change are less impacted by its outcome compared to developing countries, which will bear the brunt of the impact. This disparity of impact has given rise to the terms Global North and Global South.

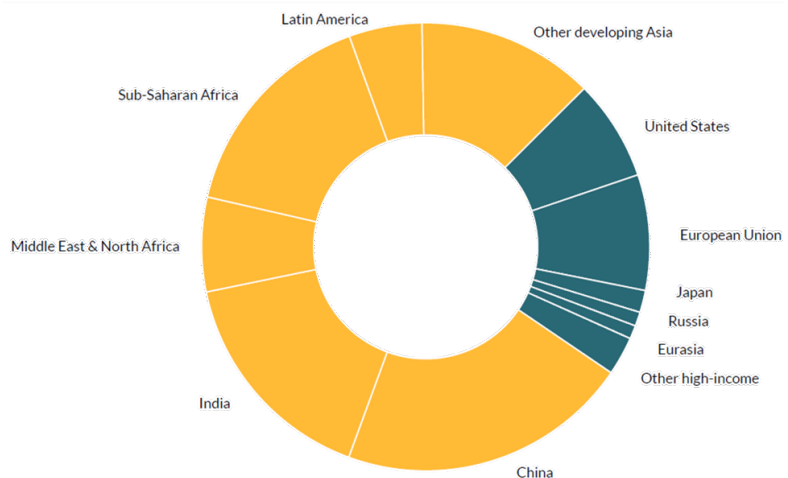
Call to Action Plan

The Climate Crisis Mitigation delegates ranked the priority of climate crisis issues and their action plans to be addressed by the global HVAC&R community in the following order:

- Extreme Weather (rain, rising temperatures, wildfires, hurricanes, flooding, droughts)
- Water
- Health Impacts (changing disease vectors, IEQ)
- Grid Impact (quality, quantity, integration)
- Migration



Who Caused Climate Change



Who is Hurt by Climate Change

Credit: Jonah Busch (2015), "Climate Change and Development in Three Charts," Center for Global Development, <https://www.cgdev.org/blog/climate-change-and-development-three-charts>

The delegates also prioritized emerging economies over developed or future economies and indicated that current products and services of the global HVAC&R community do not adequately address the climate crisis.

The **Extreme Weather** plan calls for the following steps:

- Educate: make the public aware of the impacts of weather
- Be the custodians of design weather data: specifically, define the zones of extreme weather
- Planning of the built environment (future proofing)
- Provide flexibility of spaces to address extreme climate
- Address issues on the reliability of utilities: energy, water and health impacts
- Revise climate zone data for temperature, relative humidity, precipitation, radiation data emerging due to global warming
- Provide diverse solutions to address challenges emerging from climate change fixes such as
 - Impact of deforesting around construction
 - Filtration and masks
- Create different fire guidelines to address increase in number of wildfires

It was noted that the climate crisis impact on water includes both deteriorating quality and quantity, both of which need to be addressed. The following recommendations were provided as the plan for the global HVAC&R community to address climate issues related to **Water**:

- Promote Water Reuse—Onsite treatment
- Develop and encourage the appropriate technologies for integrated water use and reuse

The **Health Impacts** plan calls on the global HVAC&R community to consider the health impact on changes made to address climate change, as was evidenced during the pandemic. The following areas should be considered when designing buildings to mitigate the impact of climate crisis:

- Reliability of onsite power storage and water
- Appropriate technology for IEQ in climate-impacted areas
- Appropriate responses to surge events
- Expand guidelines of IEQ/healthy buildings for implications emerging due to extreme weather

While not addressed fully in the Climate Crisis Mitigation presentation, plan recommendations suggested relative to **Grid Impact** caused by the climate crisis note that the Energy Security team include environmental issues when looking at the grid.

While not addressed fully in the Climate Crisis Mitigation presentation, plan recommendations suggested relative to **Migration** include that such issues may be addressed through guidelines.

Ultimately, the Climate Crisis Mitigation team narrowed down its recommendations to provide some key actions that will help support the activities outlined above:

- Develop demonstration projects using different climate zones to showcase technologies that mitigate climate change in those zones
- Initiate awards and recognize projects addressing climate change issues
- Develop climate change mitigation (long term) and adaptation (short term) guidelines
- Develop guidelines for building retrofits to address climate change impact and adaptation
- Prepare resilience/future proofing building index or rating system
- Create a center of excellence to support/assist countries/entities to help implement their commitment to mitigate climate change

These recommendations must consider the challenges faced by all stakeholders from the Global North and the Global South and provide both short-term and long-term solutions. It was the position of the attendees that the Global North should contribute more to the solutions, a position that was subsequently confirmed by Conference of the Parties 27 (COP27). All recommendations must address a commitment to carbon neutrality.

Summary

The impact on humanity from the climate crisis cannot be underscored enough. Built environments contribute directly to the climate crisis through the energy and water required to operate them and the materials used to build them.

The HVAC&R industry has a significant role to play in helping curb the effects and prepare an effective response to the climate crisis. Decarbonization is a clear action that will help mitigate

climate change; however, the recommendations provided herein will help buildings deal with the crisis that is upon us today.

The keynote address slide presentation, the report after the first breakout session, the report after the second breakout session, and the full Menti survey results for the Climate Crisis Mitigation topic can be found at the relevant bookmarks of [Appendix E](#).

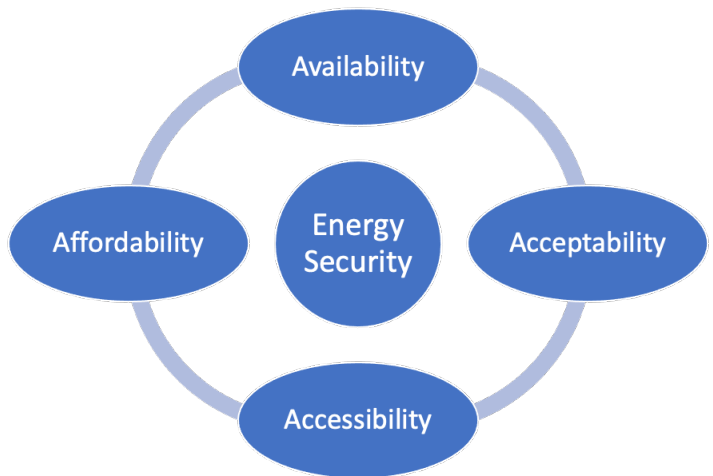
Energy Security

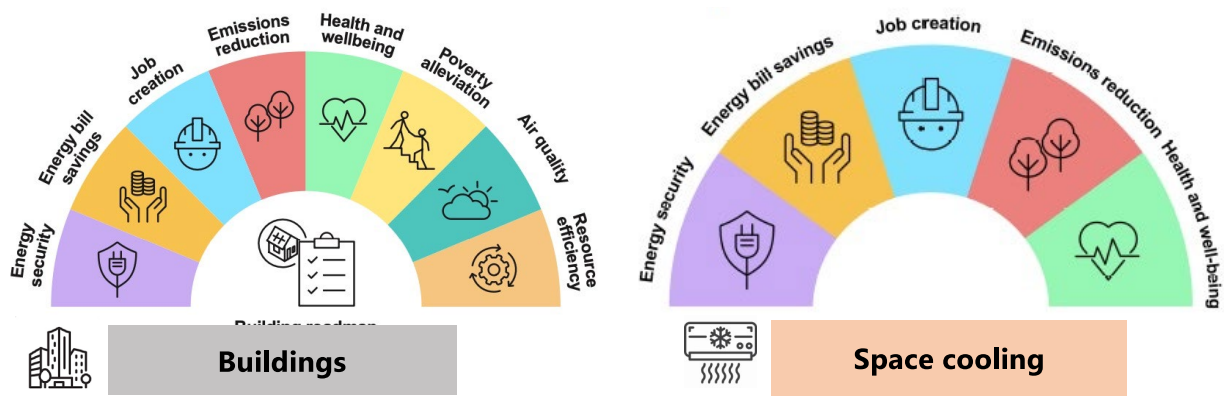
Keynote Speaker: Sylvia Elisabeth Beyer—Country Analyst, International Energy Agency
Moderator: Blake Ellis—Burns & McDonnell
Recorder: Craig Wright—Director of Finance and Administrative Services, ASHRAE

The Importance of Energy Security

Energy Security means that energy is accessible, available and acceptable and that supply is higher than demand. Energy supply must also withstand changes from events such as natural disasters, technical disruptions, and social disruptions.

Increased energy efficiency and decarbonization are basic requirements for increasing energy security. Improving energy efficiency and decarbonization of buildings and space cooling offer an additional number of economic, social and environmental benefits beyond energy savings and emissions reductions, as shown in the following figure.



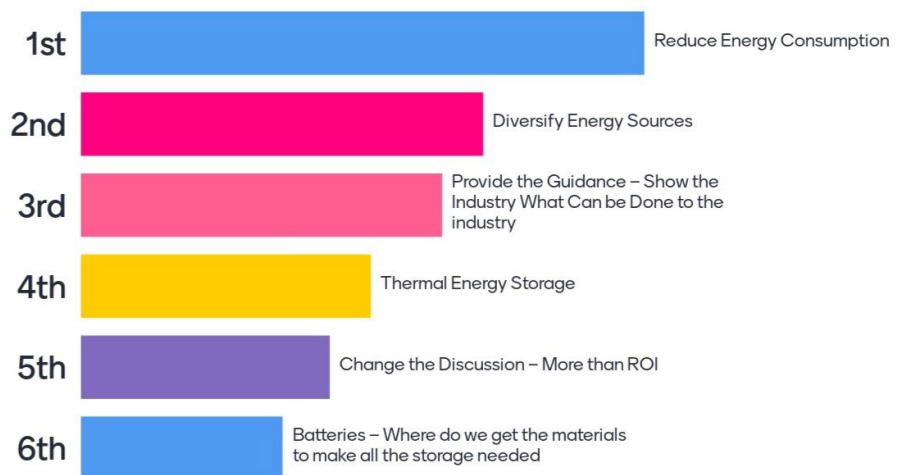


Credit: International Energy Agency (2020), “Roadmap for Energy-Efficient Buildings and Construction in the Association of Southeast Asian Nations” (<https://www.iea.org/reports/roadmap-for-energy-efficient-buildings-and-construction-in-the-association-of-southeast-asian-nations>) and “Roadmap towards Sustainable and Energy-Efficient Space Cooling in the Association of Southeast Asian Nations” (<https://www.iea.org/reports/roadmap-towards-sustainable-and-energy-efficient-space-cooling-in-the-association-of-southeast-asian-nations>)

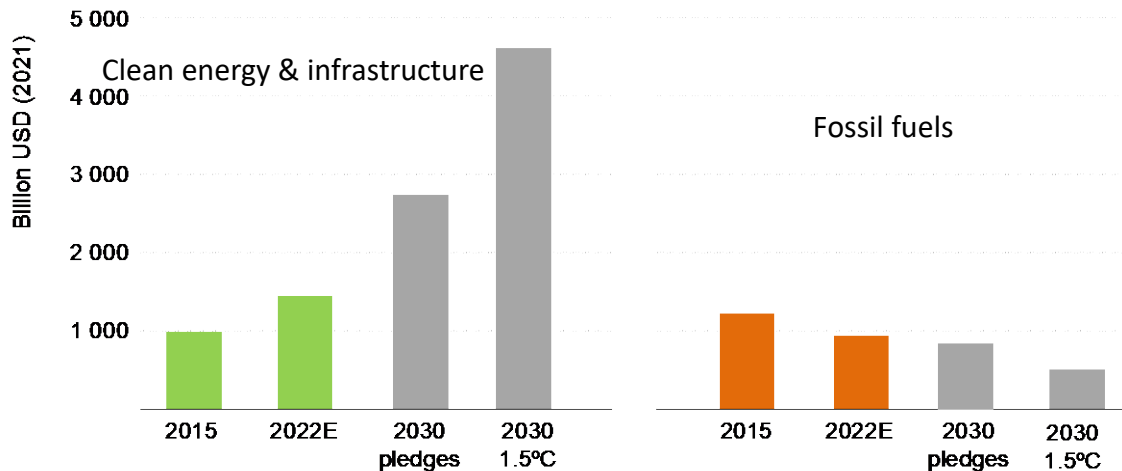
Defining the Issues

During the first Energy Security breakout session, the team developed numerous actions necessary for energy security related to the built environment. They then reduced this list to the top six issues and solicited feedback from the whole assembly, with the ranking listed in the following figure.

Additionally, 65% of the assembly felt that the HVAC&R industry should be involved in the development of government policies related to Energy Security.



As shown in the figure, investment trends don’t match up to the energy and climate crisis. Investment to bring more clean and affordable energy into the system is rising, but not quickly enough to forge a path out of today’s crisis or to bring emissions down to net zero by 2050.



Global Annual Energy Investment Benchmarked Against Future Needs

In the second Energy Security breakout session, the team discussed the results of the previous day's Menti questions to the whole assembly. They decided to focus on three of the issues identified and ranked by the assembly:

- Reduce energy consumption
- Diversify energy sources
- Change the discussion—beyond ROI

First, the team brainstormed the tasks that were needed for each goal. Then, critical tasks were identified for the action plans for each issue.

For the issue of reducing energy consumption, the tasks were identified as follows:

- Develop guidance for retrofitting buildings
 - Energy carbon reduction
- Improve auditing guidance
 - Level 0—Building portfolio analysis
 - Increase measuring and monitoring of energy use prior to renovation
- Increase fault detection and diagnostics (FDD) implementation
- Enlarge comfort envelope
- Increase rate of building retrofit
 - Workforce issues need to be addressed
 - Automate as many processes as possible (artificial intelligence)
- Right size building and equipment

For the issue of diversifying energy sources, the tasks were identified as follows:

- Determine how much “standby” energy is needed for a building
 - Varies by type of building
 - Energy storage
 - Electric storage (battery), thermal (hot and cold), building
 - Site energy generation
 - Solar, wind, geo-exchange, geothermal, nuclear
 - Grid-building interaction
- Minimize the dependency on energy that is external from the building
- Understand the source of energy available locally
- Determine how energy security affects the selection of energy sources

For the issue of changing the discussion—beyond ROI, the tasks were identified as follows:

- Engage energy providers
 - Building sector, energy provider, government
 - Signal from energy provider to building
- Building energy security is tied to electric grid energy security
- Engage building owners and real estate industry
- Carrot and stick to drive change
 - Carrot = incentives
 - Stick = increased energy cost

Call to Action Plan

The Energy Security team developed the critical tasks for the action plans for the following major issues:

- Reduce Energy Consumption
- Diversify Energy Sources
- Change the Discussion—Beyond ROI

For the **Reduce Energy Consumption** plan, the critical tasks for addressing the issue were determined to be the following:

- Educate about the use of energy standards and thermal comfort standards
 - Energy standards for the Global South
 - Enlarge thermal comfort range

- Energy standards should focus on technologies that save energy regardless of location (site/source)
- Increase rate of building retrofit
 - Provide guidance for retrofitting buildings
 - Design guidance
 - Identification of technology gaps
 - Improve auditing guidance
 - Level 0—Building portfolio analysis
 - Increase measuring and monitoring of energy use prior to renovation
 - Increase FDD implementation with artificial intelligence
 - Address workforce issues
- Right size buildings and equipment

For the **Diversify Energy Sources** plan, the critical tasks for addressing the issue were determined to be the following:

- Determine how much “standby” energy is needed for a building
- Determine how to minimize the dependency on energy that is external from the building
- Understand the source of energy available locally
 - Develop a standard (or guide) to determine quantity of standby energy source by building
 - Simplify implementation of energy storage
 - Modularize solutions
 - Technologies: Electric storage (battery), thermal energy (hot and cold), building itself
 - Simplify implementation of site energy generation
 - Simplify connecting generation sources to the grid
 - Simplify the grid-building interaction
 - Technologies: Solar, wind, geo-exchange, geothermal, nuclear

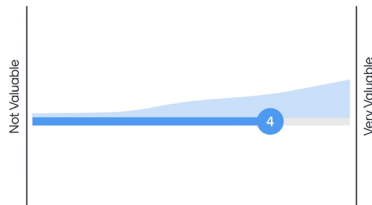
For the **Change the Discussion—Beyond ROI** plan, the critical tasks for addressing the issue were determined to be the following:

- Determine how energy security affects the selection of energy sources
- Understand that building energy security is tied to electric grid energy security
- Carrot and stick to drive change
 - Carrot = incentives
 - Stick = increased energy cost
- Hold regional and global summits
 - Energy providers and government
 - Energy supply, interconnection programs, grid building interaction

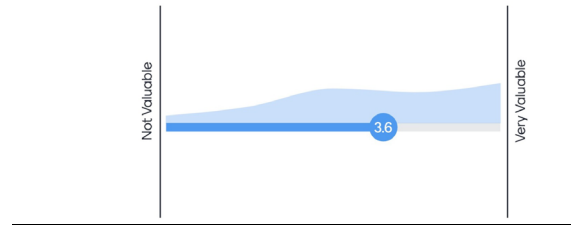
- Building owners and real estate industry
- Financial mechanisms to drive change
- Next step based on summit outcomes

Finally, the assembly was asked the following two questions:

How valuable would a summit with Energy Providers & Government be?



How valuable would a summit with Building Owners & Real Estate industry be?



The results reveal that the median of the responses to the first question is 4 out of 5 and that the median of the responses to the section question is 3.6 out of 5.

Summary

The HVAC&R industry can play an important role in reducing energy consumption, diversifying energy sources, and changing the discussion beyond ROI by developing/applying building systems that can work with multiple energy sources such as district heating/cooling and electricity (heat pumps). Systems with increased energy efficiency must be applicable both for energy renovation of buildings and for new buildings. The use of on-site energy sources such as solar systems (photovoltaic [PV] and PV-thermal, solar collector), ground-source systems and ventilative cooling will be able to secure energy when district systems and power plants fail. Finally, a data-driven control that takes into account the type of available grid energy, on-site energy availability, thermal storage potential (building mass, car battery), indoor environmental quality and user needs is important for optimization and security.

The keynote address slide presentation, the report after the first breakout session, the report after the second breakout session, and the full Menti survey results for the Energy Security topic can be found at the relevant bookmarks of [Appendix F](#).

Workforce Development

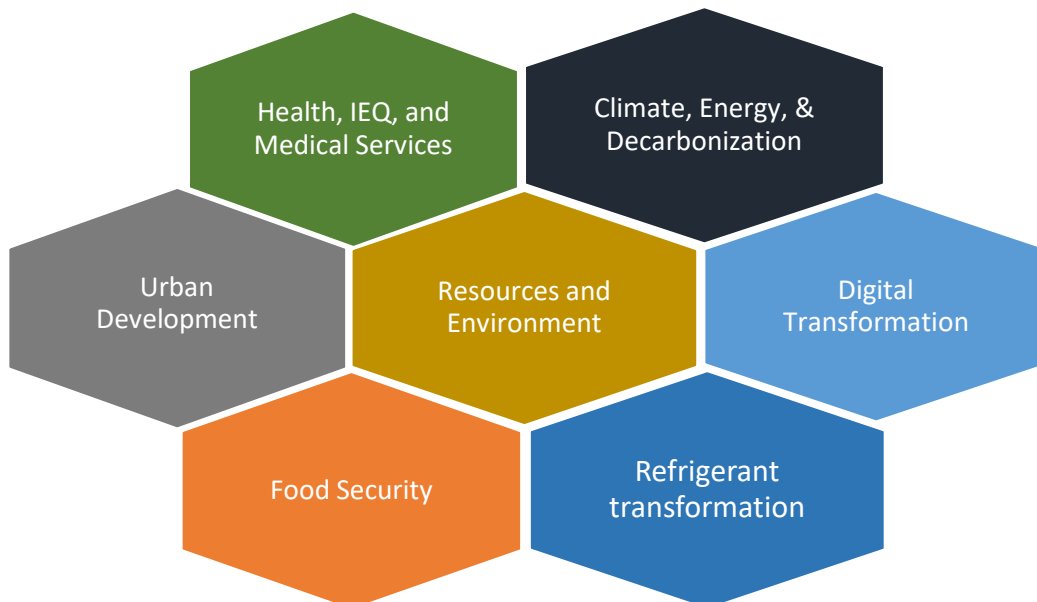
Keynote Speaker: Ayman Eltalouny—International Coordinator of Partnerships, Ozone Action, United Nations Environment Programme (UNEP)

Moderator: Dennis Knight—Treasurer, ASHRAE; CEO, Whole Building Systems

Recorder: Kim Mitchell—Chief Development Officer, ASHRAE

The Importance of Workforce Development

The workforce of today is essential to meeting our immediate needs. The workforce of tomorrow is critical to our ability to address world priorities and emerging needs. Humans have developed the capacity to advance technology at an amazing pace. Those advances are reshaping the demands for a skilled and adaptable workforce around the globe. New jobs will emerge, and existing jobs will either evolve or become obsolete. The continued transition to an automated economy will drive the current ratio of human to machine workers from 67% human to 33% machine to a projected ratio of 53% human to 47% machine by 2025.⁷



⁷ Future of Jobs Report 2020, World Economic Forum, <https://www.weforum.org/reports/the-future-of-jobs-report-2020/>

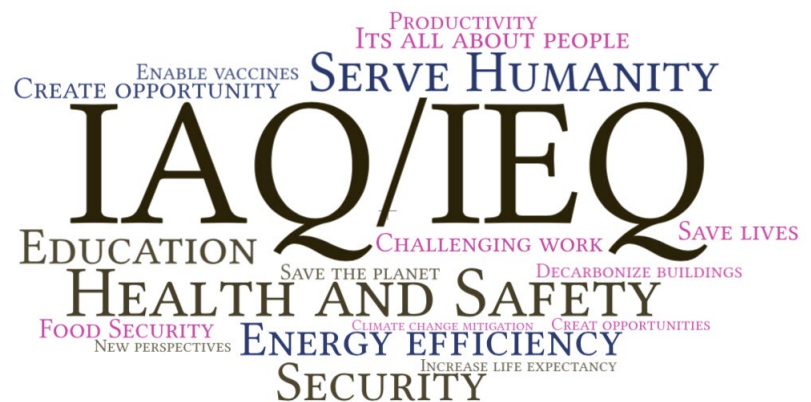
Defining the Issues

In addition to rapid advancements in technology, there are other challenges to our ability to attract and retain a future workforce. For one, the global COVID-19 pandemic resulted in a reduced workforce. Likely causes include:

- The sustained impact of the pandemic and COVID variants
- Supply chain disruptions
- Rising inflation worldwide

Adding to these causes are the war in Ukraine and policy uncertainty worldwide, resulting in a further reduction in gross domestic product (GDP) per capita to more than one half of the projected rate of 4.4% expected as the world economy recovered from the pandemic. (The actual reported rate of GDP for the past year is 2.1%.)⁸ The war in Ukraine has caused a significant spike in both energy and food costs, magnifying inflation concerns worldwide and causing a reduction in the projected GDP.⁹

The need for workforce development remains a clear and important challenge. The HVAC&R industry has much to offer individuals considering future employment. When the question was asked as to why the HVAC&R industry would offer a great career, responses of the industry leaders attending the Summit produced the word cloud at right.



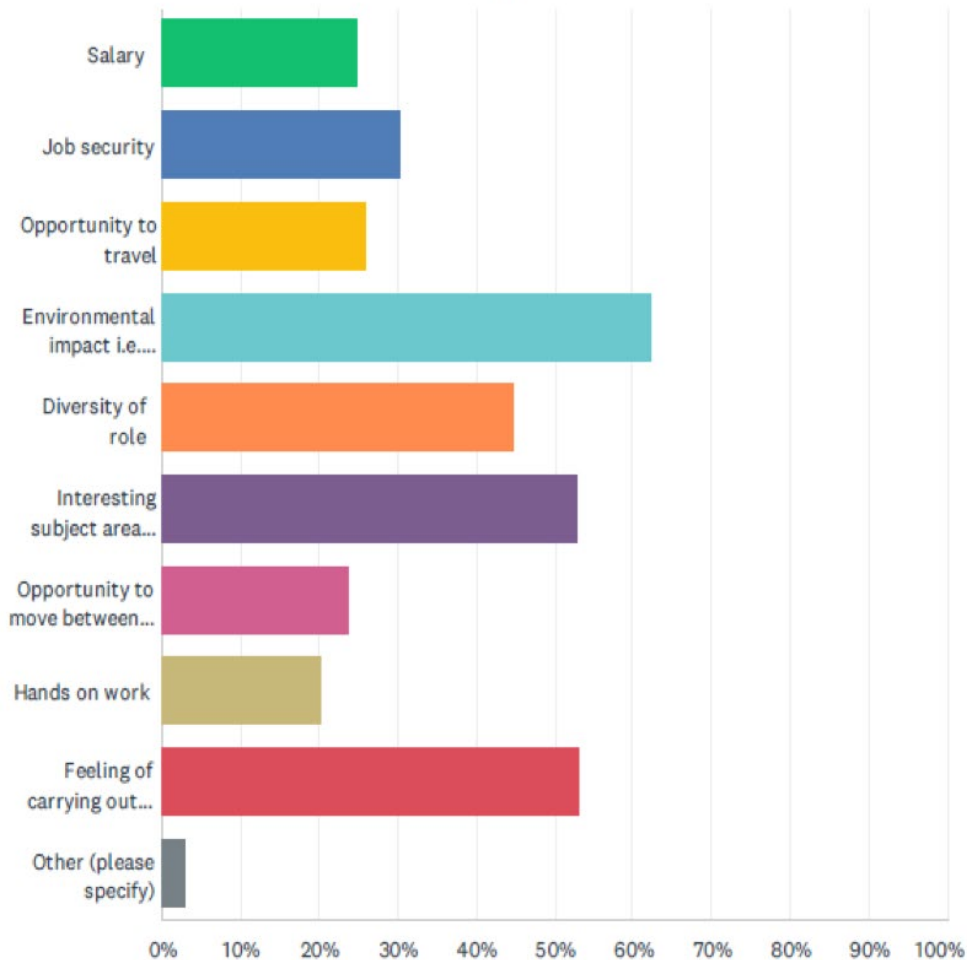
⁸ United Nations Sustainable Development Goals, No. 8—Decent Work and Economic Growth, <https://www.un.org/development/desa/disabilities/about-us/sustainable-development-goals-sdgs-and-disability.html>

⁹ Office for Economic Co-operation and Development (OECD) Economic Outlook, Interim Report September 2022, <https://www.oecd.org/economic-outlook/september-2022/>

Another question posed at the Summit was “why does what the HVAC&R industry does matter?” The answers to that question produced this word cloud:



What are top 5 characteristics you find most attractive in your RACHP career? Please select up to 5 characteristics.



Credit: UNEP Women in Cooling Survey for Refrigeration, Air Conditioning and Heat Pumps (RACHP)

Call to Action Plan

The goals for the Workforce Development call to action are the following:

- Develop a comprehensive industry-wide workforce needs assessment
- Raise the public and policy-level profiles of the industry through advocacy to policy makers and public education
- Increase the attractiveness, accessibility, and inclusiveness to careers in our industry through well-coordinated activities and actions from members, employers, chapters, regions, and society at all levels of learning, from K-12 to higher education and ultimately career-long continuing education programs

The overarching goal is to promote sustained, inclusive, and sustainable economic growth; full and productive employment; and decent work for all.

It is important to note that adapting to technology will not be enough for the workforce of tomorrow to address the critical issues of the day. As stated by Steve Jobs,

It's in Apple's DNA that technology is not enough—it's technology married with liberal arts, married with humanities, that yields us the results that make our hearts sing.

There is no better path toward achieving greater creativity and innovation and improving our ability to face challenges and solve the problems of the day than the combination of human beings working with the latest technologies to generate the maximum number of potential solutions. Much of our learning is through analogy—in other words, relating something we know to a more complex issue, situation or process we are seeking to know more about to increase our understanding and collective knowledge pool. The human mind has an amazing capacity to consider literally millions of options per second, make analogies and begin to prioritize the best paths forward. That ability combined with technology's capacity to gather data from many large and often disparate sources, categorize them, complete complex calculations and present options to us for consideration will truly maximize our human potential.

To achieve these goals three action plans are proposed:

- Needs Assessment
- Advocacy
- Attractiveness, Accessibility, and Inclusiveness

For the **Needs Assessment** plan, workforce development begins with a data-driven needs assessment. This will allow us to understand the competency, knowledge and skills/capabilities required by different groups in our industry to deliver our stated goals. Needs assessment initiatives include the following:

- Develop a comprehensive framework for a global needs assessment—now and in the future
 - Identify likely sources of data (e.g., industry, academia, government, public, etc.)
 - Reach a consensus on topics, themes, and categories
 - Understand and apply the geographical context
 - Conduct a global survey—industry, academia, and partner organizations
 - Create final report and roadmap
 - Create a map of global training capacity
 - Provide enforceable checks and feasible codes of practice

For the **Advocacy** plan, our work goes beyond energy and the environment. We must communicate how our industry is vital to safeguarding human health and supporting a modern lifestyle that improves the human condition. The action plan for developing meaningful advocacy programs, critical to attracting and sustaining a viable workforce, includes the following initiatives:

- Create an acceptable global mission statement
- Expand meaningful partnerships
- Develop a communication strategy to expand communication beyond the industry
 - Engage a marketing firm
 - Create products/tools
 - Create timelines and deliverables
- Link the roles of education—industry and ASHRAE—government
 - Enhance the pace of knowledge sharing, access to technology and education transformation

For the **Attractiveness, Accessibility, and Inclusiveness** plan, it is important to raise the profile of the industry and thereby attract the best and brightest from around the world. The action plan to promote the attractiveness of our industry and to increase accessibility and inclusiveness includes the following initiatives:

- Identify the barriers to attracting a workforce
 - Remuneration
 - Accessibility
 - Education, continuous training and career development
 - Diversity
- Develop recognition program to reinforce our increased profile
- Identify and promote role models
- Promote HVAC&R job benefits to demonstrate desirability
- Address the most current integrated design and technological applications
- Expand meaningful partnerships
- Change public expectations for environmental conditions in buildings
- Develop tools and training for the future built environment for the Global South and underserved populations within every region
- Create a plan to integrate artificial intelligence and technology-assisted work processes into the workforce
- Establish a connection with 2030 agenda goals and targets set by the United Nations with respect to its 17 universal Sustainability Development Goals (SDGs), especially in relation to workforce development:



Summary

The development of a skilled, competent and solution-oriented workforce for the HVAC&R industry is critical if we are to address the challenges of continued technological innovation and our ability to continue to safeguard the human condition and deliver a modern lifestyle—including expanding that lifestyle to underserved populations. To achieve our goals, we need to understand current and future needs, create advocacy and outreach programs to attract workers to our industry and create the programs and tools that will allow workers to adapt to new technology and use it to solve problems. Ideally, this should occur in a dynamic and repeatable style that will provide the platform of knowledge that is both user friendly and expandable to a global application.

The keynote address slide presentation, the report after the first breakout session, the report after the second breakout session, and the full Menti survey results for the Workforce Development topic can be found at the relevant bookmarks of [Appendix G](#).

Summit Summary

The ASHRAE Global HVAC&R Summit was predicated on the idea that an assembly of world leaders, representing every aspect of the HVAC&R industry, could strategically plot a course that allows our industry to take a leadership role in addressing the critical issues of the day. It follows then that the overarching goal of the Summit was to leave Istanbul with clear and compelling action plans that allow everyone to contribute to the noble goal of “Securing Our Future.”

During the course of the Summit, several common threads became clear. First, the urgency of the situation became clear, regardless of the topic. In many respects, our planet is facing a historical turning point in which our industry can, and must, play a leadership role. The second common thread running through the Summit was the interconnectedness of each of the topics. Sometimes the overlay between topics was readily apparent, as was the case between

Decarbonization and Climate Crisis Mitigation. At other times, the overlap was more subtle. As one attendee noted, if we don't solve the workforce development problem, all the other problems won't be solved either.

The last thread that ran through the Summit was one of optimism. We can do something about the critical issues of the day. We have done this before, as evidenced by our success in mitigating the damage done to the ozone layer by our use of highly reactive refrigerants. Our strategy then is the same strategy we are employing today. We come together, debate and discuss the issues, reach a consensus and then develop an action plan. It is our fervent hope that this Summit fuels the commitment to action within each person, each company, and each organization.