Yale Cooling Conference

Public Synthesis Report

The Role of Innovation and Finance in Scaling Up Lifecycle Refrigerant Management and Alternative Cooling Technologies

March 5-6, 2026 | Yale University

Carbon Containment Lab

Table of Contents

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*Photos by **Daniel Havlat.***

Executive Summary

Attendees convened at the 2026 Yale Cooling Conference with a focus on practical, on-the-ground action to cut downstream cooling emissions, amid the backdrop of a global transition from HFCs towards more climate-friendly systems built on a strong foundation in both international and U.S. law. With the emissions abatement potential of global lifecycle refrigerant management (LRM) estimated at 39 billion metric tons CO_2-equivalent ($MTCO_2e$),[1] the question of how to build operational and market models capable of scaling recovery, reclamation, and destruction has immense climate importance. Additionally, this transition presents a unique opportunity to create sustainable cooling systems that also advance affordability, energy efficiency, and workforce development around the world.

The conference brought together more than 500 stakeholders from 30 countries to identify practical near-term opportunities to advance LRM and alternative cooling technologies (ACTs). Attendees, both in-person and remote, represented equipment manufacturers and end-users, cooling startups, local, state, and national governments, regulators, NGOs, carbon credit project developers and buyers, and the financial sector.

Through keynote presentations, panels, an innovation showcase, and moderated workshops, the conference turned to the hurdles impeding execution of proven cooling strategies. Again and again, breakout sessions returned to the same practical necessities for refrigerant management and sustainable cooling to become ordinary business practice rather than episodic initiatives: better data, tighter operational integration, improved standardization, and clearer allocation of responsibility across value chains. Participants also considered what financing structures could fund recovery infrastructure, scale up ACT deployment, and support sustainable business models where carbon credits alone are not enough.

You can find the recording of the opening session here. This report provides a summary of the conference sessions and identified barriers, solutions, and actions, compiled and prioritized by the Carbon Containment Lab (CC Lab) Cooling Team.

[1] TEAP Decision XXXV/11 Task Force Report, “Lifecycle Refrigerant Management”, UN Environment Programme, May 2024. https://ozone.unep.org/system/les/documents/TEAP-May2024-DecXXXV-11-TF-Report.pdf.

Motivation for the Conference

Cooling is the invisible system that makes our modern lives possible. It also presents one of this century's greatest opportunities for climate action and sustainable development. Rising temperatures and more frequent extreme weather are driving up heat exposure, with one study finding that almost half of the global population will be living with extreme heat by 2050 on current warming trajectories.[2] Given this, it is no surprise that cooling demand is set to more than triple by midcentury.[3] Comfort cooling alone represented 3.2% of global greenhouse gas emissions in 2022, surpassing aviation and shipping.[4] Together with refrigeration, it also contributes to other pressing issues such as growing electricity demand.

The CC Lab first convened the Yale Cooling Conference in 2025 to discuss the opportunities and challenges associated with LRM. While global regulation focuses on refrigerant manufacturing and trade, downstream LRM practices represent a climate opportunity too big to ignore. The overarching takeaway from last year's cooling conference was that scaling LRM requires coordinated effort across the ecosystem to unlock climate benefits and cost savings.

This year, we focused on both LRM and **alternative cooling technologies (ACTs)** - new technologies that promise to deliver cooling without traditional vapor compression systems. We also focused on the role that **investment capital** can play in scaling up both ACTs and LRM. While much momentum has built over the last year around policy, standards, and carbon markets, the scope of the challenge posed by the changing cooling landscape demands that we as a sector rise to the occasion and accelerate action.

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[2] Lizana, J., Miranda, N.D., Sparrow, S.N. et al. "Global gridded dataset of heating and cooling degree days under climate change scenarios". *Nat Sustain* (2026). https://doi.org/10.1038/s41893-025-01754-y

[3] United Nations Environment Programme (2025) – "Global Cooling Watch 2025: The Free Degrees." *UN Environment Programme*. https://wedocs.unep.org/handle/20.500.11822/48926

[4] Hannah Ritchie, "Air conditioning causes around 3% of greenhouse gas emissions. How will this change in the future?", *Our World in Data,* 2024.
https://archive.ourworldindata.org/20260304-094028/air-conditioning-causes-around-greenhouse-gas-emissions-will-change-future.html
https://ourworldindata.org/air-conditioning-causes-around-greenhouse-gas-emissions-will-change-future

Day One: Setting the Stage

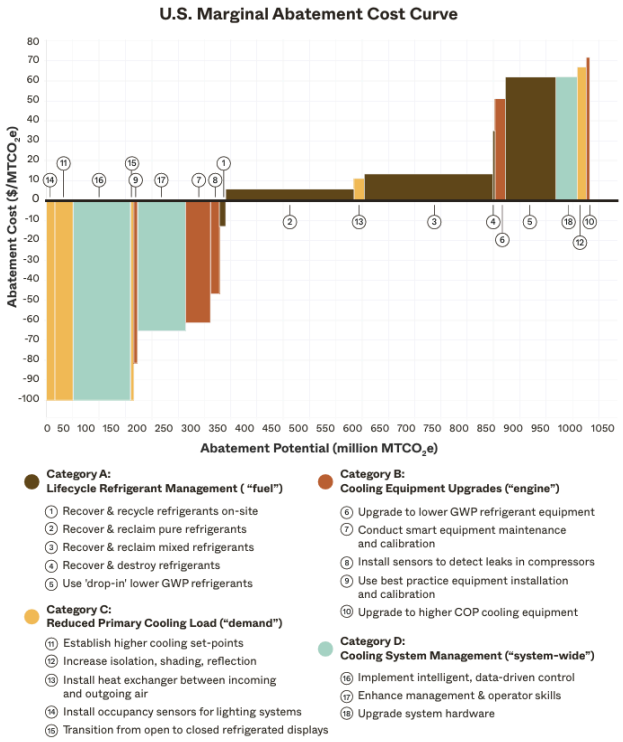
Opening Plenary

The conference opened in the Yale School of Management's Zhang Auditorium, drawing nearly 300 in-person attendees and over 200 online participants.

The remarks began with an overview of the cooling landscape from the CC Lab's Senior Managing Director, **Anastasia O'Rourke**. She emphasized how this often-overlooked system underpins not only familiar applications, such as comfort cooling and cold-chain logistics, but also less visible ones across manufacturing, digital infrastructure, and defense. As global development and rising temperatures drive greater reliance on cooling, the refrigerants that make it possible pose a major climate risk. While existing policies aim to phase down new production, they largely miss the vast stockpiles of gases already in circulation. LRM targets this gap. Momentum for LRM has grown in recent years through initiatives such as the Global Cooling Pledge, a UNEP-ASHRAE collaboration, and the increasing inclusion of cooling in nationally determined contributions. Still, achieving deep progress will require moving beyond commitments and upstream policy toward sustained, system-wide implementation.

Next, **Scott Stone** of Glencoe Strategies gave updates on the international and U.S. policy landscape around cooling, including on the American Innovation and Manufacturing Act (AIM Act). A bipartisan coalition passed the AIM Act in December 2020 after years of industry advocacy, providing a durable legal foundation for emissions reductions through production and consumption phasedowns. With this in place domestically and the prevalence of global policies built on the Montreal Protocol, the transition now turns on execution.

In many areas, cost-effective solutions are ready for implementation. **Ethan Olim** of the CC Lab presented the Lab's recent study on cooling in the commercial real estate sector. The study projected sector emissions of 12.8 billion $MTCO_2e$ in the U.S. and China from 2026 to 2060 - equivalent to about a quarter of global annual emissions. It also included a detailed cost curve of eighteen mitigation opportunities, finding actions that could abate more than five billion $MTCO_2e$ at negative cost and several billion more at less than $100/$MTCO_2e$, with the greatest wins coming from data-driven controls and maintenance as well as refrigerant reclamation.[5] Seen at right is the study's cost curve for the U.S., showing the financial and climate impact of various emissions mitigation measures.



Next, a panel of industry experts came to the stage to discuss their experiences with LRM practices. The panel, moderated by **Willem Vriesendorp**, included **Wayne Rosa** of Ahold Delhaize, **Samantha Slater** of the Air-Conditioning, Heating, and Refrigeration Institute, **John Hurst** of the Alliance for Responsible Atmospheric Policy, and **Dane Waund** of Orbia. They began with a conversation on regulatory frameworks, emphasizing the importance of stability and consistency to private sector decision-making. Industry players who have invested large amounts in the current refrigerant transition are motivated to see it through, regardless of the shifting political environment in the U.S., and are also driven to engage with LRM practices out of climate commitments and financial savings. Another topic of conversation was vulnerabilities in international supply chains, with panelists focusing their discussion on the importance of domestic refrigerant production and LRM to supply security. Panelists shared a sense of momentum about the cooling transition, with an ethos that places climate action alongside, rather than in opposition to, business strategy.

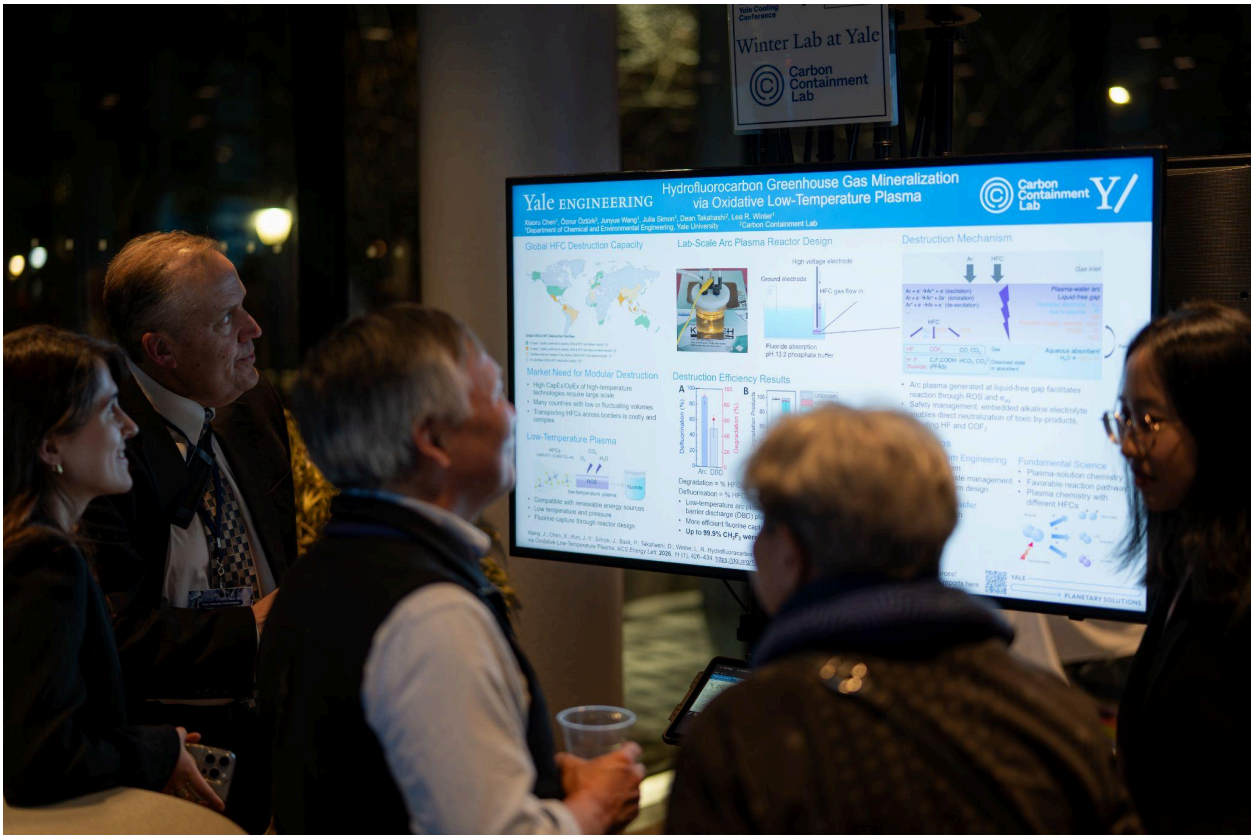
[5] Willem Vriesendorp, Anastasia O'Rourke, Ethan Olim, Selin Gören, Sage Wen, *Bending the Curve: Cost-effective cooling emissions reduction pathways for commercial real estate in China and the U.S.* Carbon Containment Lab, 2026. https://carboncontainmentlab.org/publications/bending-the-curve

After the Industry Panel, **Randy Spock** of Google took the stage to make a major announcement on corporate superpollutant action. The Superpollutant Action Initiative, a joint effort coordinated by the Beyond Alliance and including Amazon, Autodesk, Figma, Google, JPMorganChase, Salesforce, and Workday, is centered on a pledge to deploy $100 million through 2030 for action on superpollutants, aiming to pull the emergency brake on global warming and catalyze further action. **Anastasia O'Rourke** then announced that the CC Lab is leading the development of a research-driven, actionable Superpollutant Roadmap for companies as well as an adjacent Superpollutant Academy, a training program for carbon market buyers. **Zoe Dawson** from êffectera announced a forthcoming RFI/RFP for Scope 3 Action on HFC emissions reduction.

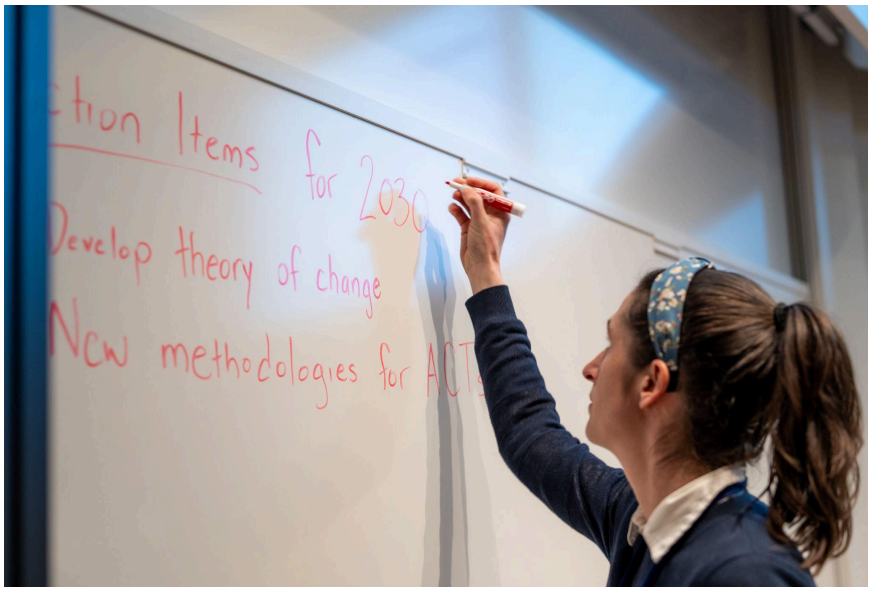
Next, a panel of leading climate investors, including **Megan Phelan** of Acceler8 Ventures, **Frances Lodge** of Galvanize, **Randy Spock** of Google, and moderator **Anastasia O'Rourke** of the CC Lab, dove into various opportunities for mission-driven capital to catalyze the cooling transition. Panelists noted that the sector is a clear fit for many funds because of overlapping policy pull and economic potential, yet investment opportunities from cooling start-ups remain rare. Investors also need improved data from startups to build operational and financing models. Panelists also discussed carbon credits as a revenue source, with consensus that it is difficult to build business models on credits alone. Spock shared Google's approach of catalyzing projects that offer non-market climate benefits and stewarding them towards self-sufficiency.

Finally, the plenary turned to the role of innovation in overcoming the challenges of the coming decades. **Selin Gören** of the CC Lab explained that innovative management of the existing bank of high-GWP refrigerants is critical, as are the next-generation technologies represented by ACTs. Fortunately, trailblazers exist across the cooling space. Seventeen ventures pitched their technologies on stage, with innovations crossing boundaries of engineering, materials science, and business development.

Founders dove into the specifics of their technologies during the evening's Cooling Innovation Showcase, a meet-and-greet where attendees enjoyed dinner and drinks while building new connections. The innovators in attendance included **A-Gas**, **Artyc**, **ChillSkyn**, **Clema**, **êffectera**, **Exergyn**, **Fexa Trakref**, **Hudson Technologies**, **Luxwall**, **Magnotherm**, **Mimic**, **Pascal**, **Recoolit**, **SkyCool Systems**, **Therm**, **Tradewater,** and the **Winter Lab at Yale**.



Day Two: Building the Roadmap



On March 6, stakeholders reconvened for an invitation-only day of workshops to identify near-term actions across capital, policy, and industry to accelerate the transition to sustainable cooling systems. Participants engaged in breakout conversations identifying opportunities, challenges, and actions that would advance the field, with an emphasis on near-term priorities. Moderators guided the conversations with support from rapporteurs and note takers, under Chatham House Rules.

Breakout 1: Unsticking the Operations Opportunity

This session, moderated by **Aleisha Khan,** Executive Director of the Refrigerant Emissions Elimination Forum, explored why many proven LRM strategies are slow to scale across stakeholder and system types. The group also discussed current drivers for LRM: **regulatory compliance**, **cost savings**, **following best practices**, and **climate goals.** While attendees understand these benefits, motivating action can be difficult because savings are often slow to accrue, services can be hard to coordinate, and the climate impact of refrigerants is rarely top of mind. Participants also discussed the potential for ACTs to immediately add value by meeting cooling demand and cutting energy costs. Key struggles shared by stakeholders included:

- The enforcement gap around end-of-life practices makes it easier to ignore leaks and vents than to properly manage them.
- Many stakeholders do not understand the energy efficiency losses caused by leaks.
- Pressure exists from those with business models that rely on refilling leaky equipment and selling gas.
- A lack of available information, expertise, and resources hampers those who do want to act responsibly.

To overcome these hurdles, participants reached consensus on the following solutions:

- ☐ Collecting and sharing data on compliance and cost benefits of LRM practices.
- ☐ Integrating LRM, refrigerant use, and performance data into existing data collection systems - for example, into building management or asset tracking systems.
- ☐ Helping to proactively build a market for reclaimed refrigerant, which will create incentives to minimize leaks and venting and displace virgin production of high-GWP gases.
- ☐ Building LRM practices explicitly into green building standards, such as LEED Operations credits.
- ☐ Creating new materials and guides on best practices for various stakeholders (tenants, contractors, building owners, etc.) to make information accessible and actionable.
- ☐ Framing the LRM opportunity around financial and health benefits to gain buy-in from audiences less interested in climate action.

Additionally, a “wild idea” was shared:

- ☐ Adding recovery reporting standards to technician licensing requirements, such as Section 608 in the U.S.

Breakout 2: Value Chains & Insetting

In this session, moderated by **Zoe Dawson**, Technical Sustainability Program Leader of êffectera, participants gathered to discuss how insetting strategies can drive measurable Scope 3 emissions reductions in cooling, looking for points of leverage across supply chains. Scope 3 emissions, while often easy to ignore, make up the bulk of climate impact for many companies. Attendees shared several obstacles, including:

- Granular data on companies' individual value chains are hard to come by, and data tools have not yet been adopted widely enough to grow universal understanding.
- Responsibility for refrigerant banks, leaks, and venting is not clearly assigned between owners, servicers, original equipment manufacturers (OEMs), and producers.
- Some industry players are willing to move extremely fast, while others have more inertia. Solutions need to be available to meet companies at their preferred pace.
- It is already difficult to monitor and control the behavior of technicians working on-site, let alone on equipment far away with suppliers.
- LRM is often framed exclusively as a climate issue, which alienates some potential collaborators.

Participants proposed several solutions to the above problems:

- ☐ Building the datasets to allow corporations to make informed decisions about their suppliers' Scope 3 actions; ideally using tools in existing engagement and data platforms.
- ☐ Developing procurement specifications, such as contract language, requiring low-GWP refrigerants, reclaimed refrigerants, and LRM, that can be piloted and scaled.
- ☐ Educating actors throughout value chains on the economic, security, and safety benefits of LRM.
- ☐ Clarifying the role that insetting can play as a corporate climate strategy for different types of companies and how this can help meet companies' climate goals and claims.
- ☐ Conducting pilots and studies for reductions within known hotspots of refrigerant emissions such as food systems.

Breakout 3: Carbon Markets

Moderated by **Anastasia O'Rourke**, Senior Managing Director of the CC Lab, this breakout's goal was to identify opportunities for the voluntary carbon market (VCM) to support LRM, ACTs, and other areas of the cooling transition. Participants agreed on obstacles across several dimensions:

- There are gaps in methodologies available for some activities - for example, little coverage exists for ACTs, and some geographic regions are excluded from certain methodologies.
- There are limits to what major VCM registries will take on, and newer registries seeking to fill these gaps are still building credibility and seeking recognition from international bodies.
- Infrastructure for LRM practices, such as certified testing labs or destruction facilities, is currently unavailable in many countries. Project developers in these countries must build or coordinate such infrastructure themselves, which can be expensive and time consuming.
- Clear, committed demand from buyers of carbon credits - necessary to spur development and investment - is lacking today. This would be boosted by standardization around how activities funded by the VCM tie into buyers' net-zero claims and use of SBTi standards.
- Regulatory uncertainty persists on what will remain VCM eligible, given evolving legal landscapes and increasing implementation of compliance markets in service of Paris Agreement goals.

A broad set of action items emerged from participants, which were prioritized by the group. Key actions included:

- ☐ Supporting buyers making compensation claims using superpollutant mitigation credits through research and standard setting.
- ☐ Encouraging advanced market commitments and forward offtake agreements to stabilize market signals.
- ☐ Investing in data collection at the regional or country level to inform baselines, infrastructure needs, and refrigerant inventories.
- ☐ Developing new VCM methodologies for ACTs and ultra-low GWP systems.
- ☐ Pilot testing new methodologies and data collection approaches to fit the unique needs of different regions and reporting back results to improve methodologies.
- ☐ Building connections between industry, VCM actors, and policymakers for effective regulation to enable the VCM to serve as a bridge to policy development.

Breakout 4: The Role of International Institutions

This breakout, moderated by **Maas Goote** of Carraway Strategies, focused on how stakeholders can leverage international institutions to accelerate the adoption of LRM practices and scale ACTs, aiming to identify concrete entry points within frameworks like the Montreal Protocol, technical bodies such as its Technology and Economic Assessment Panel, and financial mechanisms such as the Multilateral Fund.

Participants expressed several obstacles to accessing these international mechanisms:

- The lack of proximity and relationships between international institutions and private-sector actors, especially for startups.
- The slow speed at which international institutions move, which results in hurdles including outdated data and contact lists and delayed impact from action.
- The shortcomings of isolated projects led by international institutions without involving private-sector stakeholders, such as pilot ODS destruction projects that lacked sustained financing.

Priority actions from this session included:

- ☐ Identifying points of entry to international bodies and frameworks, such as national governments.
- ☐ Gathering accurate data via collaborations between the private and public sector, including data sharing by companies through secure mechanisms.
- ☐ Companies being more proactive in informing international institutions on the technical aspects of projects and sharing their expertise to help bridge the gap between policy and practice.
- ☐ Leading the adoption of LRM and ACTs with projects at scale to move beyond pilot projects, for example through public-private partnerships.

Breakout 5: Subnational Policy

In this session, moderated by **Rob Klee**, a Senior Lecturer at the Yale School of the Environment, participants discussed the potential for subnational governments to accelerate cooling emissions reductions. Hurdles that participants agreed on included:

- Regulatory patchworks, such as different GWP metrics across states, which create a high administrative burden.
- Limited capacity at state agencies, including constrained staff and funding, to design and administer refrigerant policies.
- Lacking real-world data, especially on small commercial and residential systems, and high costs to collect that data.
- Funding issues around LRM implementation, with particular concern around costs being passed through to small consumers.
- Workforce shortages, with the HVAC industry short hundreds of thousands of technicians and therefore struggling to add new responsibilities to practices.

Key action items that gained consensus included:

- ☐ Adding refrigerants, specifically reporting and leak detection requirements, to building performance standards to improve measurement and inform action.
- ☐ Using public portfolios and procurement as demonstration markets for next-generation cooling equipment, planting the seeds to scale these systems and practices.
- ☐ Standardizing policy across states to increase best practices without creating excessive compliance burdens.
- ☐ Encouraging and funding workforce development through programs like apprenticeships and supporting continuing education for current technicians.

Additionally, a few ‘wild ideas’ were shared, including:

- ☐ Taxing high-GWP refrigerants, as is done in Europe.
- ☐ Instituting extended producer responsibility schemes, placing the financial burden of end-of-life compliance on OEMs to stimulate much greater uptake of LRM.

Breakout 6: Leveraging Key Lenders: Green Banks & CDFIs

In this session, moderated by **Trevor Thompson**, Environment & Climate Director at the African American Alliance of CDFI CEOs, the conversation centered on the role that key lenders, such as green banks and community development financial institutions (CDFIs), can play in commercializing LRM and ACT solutions. The goal was to generate guidance and insights from mission-driven lenders on how to create practical models to reduce upfront costs and de-risk projects.

The session identified several key actions:

- ☐ Lenders providing concessional, patient capital to absorb early-stage risk for LRM and ACT projects, drawing on mechanisms already deployed for climate impact investments.
- ☐ Lenders exploring how innovative loan models, such as Connecticut Green Bank's Smart-E program, currently used for home energy efficiency and residential cooling upgrades, could be adapted to support additional cooling technologies and applications beyond the residential sector.
- ☐ Lenders integrating refrigerant management into established clean energy initiatives, such as residential solar, heat pumps, and energy efficiency rebates, rather than building siloed programs from scratch.
- ☐ Startups preparing the market by generating and sharing credible data, especially around cost savings and efficiency improvements.
- ☐ Startups exploring how environmental attributes such as carbon credits and efficiency certificates can improve project economics and attract private capital, and lenders assessing how these attributes can be factored into financing structures.

Building the 2026 Action Agenda

Across the sessions, opportunities emerged for no-regret actions in five key areas. First, stakeholders need **data** to gain insight into their cooling emissions, improve the ability of policymakers to create informed regulation, and substantiate offset credits and environmental claims. Second, policymakers can improve **regulation and standards** to better consider refrigerant impacts and bridge the public and private sectors. Third, **financing** for the transition could come from public and mission-driven lenders aiming to derisk emerging technologies and from the treatment of cooling as a new vertical at early-stage investment firms. Fourth, the **voluntary carbon market** can align incentives by creating methodologies for ACTs, synergizing existing methodologies, and growing the market with new buyers. Finally, **communication and information** need to improve to ensure a wide understanding of the financial, environmental, and operational benefits of LRM and ACTs.

Attendees discussed these results in a closing conversation, where rapporteurs shared information from each session, leading to further insightful conversations between attendees. Although consensus actions were plentiful, so were differing ideas on next steps to take, highlighting the value of continued conversations and research. The conference closed with a shared sense of excitement and momentum.

Appendix: Pre-Conference Workshops

Before the conference began, two workshops were hosted by CC Lab partners for gathered stakeholders.

The first, led by the **U.S. Green Building Council** and **RMI**, was entitled "**Integrating Refrigerant Strategy into Low-Carbon Building Design**." The workshop focused on strategies for designers to reduce emissions from refrigerants in new buildings, and followed up on a workshop held at Greenbuild in November 2025. Roughly thirty participants attended, representing architects, engineers, NGOs, manufacturers, and regulators. Participants shared multiple pathways to cut emissions, with a focus on strategies that can be implemented now, including right-sizing equipment, thermal storage, and passive cooling technologies, as well as examples of successful whole-system design approaches. Another topic was the use of "natural," ultra-low-GWP refrigerants such as CO_2, which have not yet been incorporated into building codes, safety requirements, and equipment design. The session ended with a presentation of potential tiered approaches that can combine multiple strategies to cut emissions and a discussion on next steps, including new design workflows, development of new equipment, and improving installation requirements.

The second workshop, co-hosted by **Cascade Climate** and the **CC Lab**, was entitled "**Ensuring Effective Guardrails and Pilots for Catalytic HFC Destruction Projects in Article 5 Countries**." Participants discussed the opportunity to leverage carbon finance to kick off a wave of ODS and HFC recovery and destruction capacity build-out in import-dependent Article 5 countries. If designed correctly, this push has the potential to support Article 5 countries in meeting their Montreal Protocol/Kigali Amendment phasedown and reporting obligations and to unlock new sources of funding to accelerate their refrigerant transition.

Participants discussed the opportunity to test these projects in voluntary markets before regulators codify them in compliance frameworks, and explored the distinction between project-level data checks versus underlying field-level data needs. In particular, participants debated the effectiveness and practicality of standards to mitigate perverse incentives, the lack of available baseline data, how to avoid undercutting countries' MOP obligations, and trade-offs between reclamation and destruction in Article 5 contexts. Participants agreed on the value of leveraging carbon finance to grow LRM capacity in regions with high venting rates, contingent on establishing appropriate guardrails, which they committed to build.