Carbon Containment Lab

Yale Cooling Conference

Public Synthesis Report

Name of the Game: *Establishing a Coordinated Strategy to Scale Life-Cycle Refrigerant Management*

February 20-21, 2025 | Yale University

Yale Center for Business and the Environment

SUSTAINABLE PURCHASING LEADERSHIP COUNCIL

REEF REFRIGERANT EMISSIONS ELIMINATION FORUM

Yale ISPS

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Overview

On February 20-21, 2025, The Carbon Containment Lab—alongside its partners and supporters at the Yale Center for Business and the Environment (CBEY), the Institution for Social and Policy Studies at Yale (ISPS), Sustainable Purchasing Leadership Council (SPLC), and Refrigerant Emissions Elimination Forum (REEF)—convened a high-impact group of industry experts, advocacy organizations, policymakers, and academic researchers at The Yale School of Management to collaborate on advancing the scale-up of lifecycle refrigerant management (LRM) practices.

On the first day of the conference, the Public Opening Plenary featured keynote speakers who described the scale of the climate problem and the potential for LRM to address it. Then, industry leaders from A-Gas, IKEA, Stulz, Trane Technologies, and an expert from the grocery sector shared best practices and case studies on refrigerant management. **A total of 400 participants from more than 50 countries joined the event either in person or online. You can find the recording of the session here.**

On the second day, the invitation-only workshop brought together 67 stakeholders from across the refrigerant ecosystem, including end-users of refrigerants, equipment manufacturers, reclaimers, advocacy organizations, policymakers, and carbon credit project developers and buyers. From the workshop, numerous opportunities to integrate LRM solutions into broader business operations surfaced, includinga phased implementation approach, elevated data collection and management strategies, improved standards and recognition programs, and increased ambition by all upstream and downstream stakeholders.

This synthesis report provides an executive summary of the key action items to accelerate and scale up LRM that garnered the strongest consensus during the conference and are likely to gain the most momentum in the current political and industrial landscape, as compiled and prioritized by the Carbon Containment Lab team.[1]

[1] This Public Synthesis Report was written by Selin Gören and Anastasia O'Rourke of the Carbon Containment Lab. Notes during the conference were taken by Allie Wiegel, Leah Clayton, Öznur Öztürk, Cici Xu, Eleri Phillips, and Teddy Horangic. The Report was reviewed by Scott Stone, Sinéad Crotty, and workshop participants; proofread by Nicole Gotthardt. Photo credits: Daniel Havlat.

Background and Motivation for the Conference

While the Kigali Amendment to the Montreal Protocol mandates a phasedown in HFC production and consumption, it does not address *downstream* emissions of HFCs from equipment use and disposal. Consequently, downstream refrigerant management remains insufficiently addressed, under-adopted, and under-financed.

As the demand for refrigeration and air conditioning expands globally, large quantities of HFCs are stockpiling/accumulating in installed equipment, increasing the "bank" of potential emissions.

Unless downstream interventions are taken, these legacy HFCs are destined to enter the atmosphere at alarming rates. Some estimates indicate the global implementation of **LRM best practices could prevent over 39 gigatonnes CO_2e between 2025 and 2050,** an amount equivalent to one year's worth of global energy sector emissions.[2]

LRM strategies complement other important methods to "decarbonize" cooling, including transitioning to low or zero Global Warming Potential (GWP) cooling approaches. Key LRM strategies can include:

- Conducting inventories of HFC gases and HFC-containing equipment.
- Detecting and preventing leaks.

[2] TEAP Decision XXXV/11 Task Force Report, "Lifecycle Refrigerant Management", Volume 4, May 2024. https://ozone.unep.org/system/les/documents/TEAP-May2024-DecXXXV-11-TF-Report.pdf.

- Recovering and recycling or reclaiming refrigerants to reduce 'virgin' HFC demand.
- Destroying refrigerant that would otherwise be vented in environmentally sound destruction facilities.

In the current U.S. political landscape, the future of federal implementation of the American Innovation and Manufacturing (AIM) Act and the prospects for regulatory action remain uncertain. However, state and local policies have the potential to fill gaps emerging at the federal level. For example, California requires reclaimed refrigerants to be used when servicing state-owned air conditioning and refrigeration equipment and prohibits the sale of bulk "virgin" refrigerants above a certain GWP. Other states may follow suit.

End-users of refrigerants are well-positioned to make an important contribution to global climate change mitigation through mitigating emissions of these super-pollutants and accelerating the transition toward energy-saving and low (or even zero) GWP cooling systems. By overcoming operational and management challenges, end-users can comply with regulatory requirements, reduce costs, and help achieve their organizations' climate goals.

The collaborative efforts of states and voluntary commitments from private sector stakeholders represent the most viable path to achieving robust LRM. These measures are essential to ensuring a sustainable refrigerant supply chain and addressing the challenges posed by the impending HFC phasedown.

Summary of Workshop Discussions

Opening Session: Industry Action to Scale Up LRM

On February 21, the workshop opened with a collective discussion focusing on Industry Action to Scale Up LRM. The opening session emphasized that despite their high Scope 1 and 3 greenhouse gas (GHG) emissions impact, refrigerants are often overlooked in corporate and commercial real estate. This oversight is partly due to complex management structures and a lack of visibility on the issue. Current financial and GHG accounting frameworks do not fully capture the costs and impacts associated with refrigerants.

Addressing refrigerant management challenges in the industry requires a multi-faceted approach. Specifically, approaches include integrating LRM into strategic planning, strengthening procurement policies, leveraging financial opportunities for cost savings, investing in workforce training, improving tracking and reporting, and promoting industry collaboration. By reframing refrigerant management as a critical component of climate policy that can achieve cost savings, the industry can drive significant reductions in greenhouse gas emissions.

After the morning session, the participants split into three breakout groups, each focusing on developing action agendas to drive LRM forward. The three workshop topics included: (a) integrating LRM into operations; (b) key data gaps and how we can fill them; and (c) integrating LRM into standards and purchasing specifications.

Breakout Session 1: Integrating LRM Into Operations

When it comes to LRM, operations are where the "rubber meets the road." This breakout discussion addressed the increasing need for comprehensive and standardized refrigerant management strategies; awareness; and toolkits for refrigerant end-users (real-estate and property management groups, universities, grocery and retail stores, etc.) and downstream stakeholders (especially technicians, engineers, contractors).

The discussion was centered around tackling key industry challenges, such as regulatory compliance, data gaps, complex organizational structures, resource misalignments, lack of public awareness, and limited clarity on the financial costs and incentives for LRM. Despite an increasingly uncertain information landscape, breakout attendees underscored the importance of two main facets: 1) centering LRM integration around its low-hanging positive economic returns on reducing scope 1 & 3 emissions and 2) expanding stakeholder collaboration across the entire supply chain (upstream, midstream, and downstream) to highlight LRM as a mainstream ESG agenda and a monumental climate opportunity.

Breakout Session 2: Key Data Gaps and How To Fill Them

As highlighted in the morning session, refrigerant emissions are often invisible and dispersed. Better data practices are needed throughout the value chain. Gathering more refined data will inform which actions to prioritize to maximize LRM's impact.

Motivated by this goal, the breakout discussion on "Key Data Gaps and How To Fill Them" set out to identify key data gaps in the refrigerant lifecycle (upstream, equipment/inventory, and downstream) and discuss how to address them to improve refrigerant management and reduce emissions.

Breakout discussions concluded that better data on production processes and combating illegal trade are needed upstream. To improve equipment and inventory management, there is a need for assessments of leak rates (both in-use and in stockpiles) and guidance on recovery equipment and infrastructure. Downstream, there is a significant need for expanded data on stockpiles, leak rates during reclamation, and the environmental impacts of HFOs and PFAS. Compliance, benchmarking, and cost data are also lacking, highlighting the need for comprehensive data improvements across the lifecycle.

Breakout Session 3: Integrating LRM Into Voluntary Standards & Purchasing Specifications

During the breakout discussion on "Integrating LRM into Voluntary Standards & Purchasing Specifications," participants engaged in discussions across multiple suites of standards that can be modified and enhanced to motivate action on LRM. The theory of change is to map and build on existing voluntary standards and recognition programs that are already influential, ensuring that they adequately address LRM when appropriate and reach a wide audience.

The discussions highlighted the need for easy-to-digest, actionable tasks relevant to each standard domain to facilitate effective implementation. Participants emphasized the importance of attracting more experts in LRM and fostering collaboration to leverage diverse perspectives and expertise. There was a strong call for simpler guidance and tools to reduce complexity and enhance user experience, making LRM practices more accessible across these suites of standards.

Yale Heating & Cooling Facilities Tour

After the lunch break, the Yale Environmental Health & Safety team led participants on a tour of the Yale School of Management's heating and cooling systems. During the tour, the Office of Sustainability provided a brief presentation on Yale's greenhouse gas (GHG) accounting process and refrigerant management strategy, which is currently focused on conducting a detailed inventory.

Fireside Chat on the Shifting Policy Landscape

In the afternoon, Scott Stone–an attorney with more than two decades of experience in refrigerant regulation and founder of the energy and environmental law firm Glencoe Strategies–gave a fireside chat on the shifting political and regulatory landscape under the new administration and its implications for LRM policies.

The Trump Administration has prioritized rolling back federal requirements in a broad deregulatory push and cutting budgets and staff across the federal government. However, the process of rolling back federal standards remains subject to complex rulemaking procedures, such as public notice and comment periods and opportunities for judicial review. Notably, staff and budget cuts at the EPA will affect the agency's capacity to conduct such rulemaking. This raises questions over the extent and pace of the administration's deregulatory drive, particularly over the next two years.

Importantly, the AIM Act's core requirements are inscribed in statute, meaning it would take an act of Congress–and not an EPA rule–to repeal them. This is unlikely, given the AIM Act's broad bipartisan support and strong backing from the U.S. Heating, Ventilation, Air Conditioning, and Refrigeration (HVACR) industry. However, other requirements under the AIM Act—such as GWP limits for refrigerants in new equipment and leak monitoring and repair mandates—can be weakened or delayed, potentially slowing implementation and sowing confusion in the marketplace.

Additionally, regulatory enforcement at the federal level is expected to decline, with the possible exception of actions against the illegal refrigerant trade, which harms U.S.-based producers and reclaimers.

In addition, the Congressional Review Act is being used to overturn some Biden-era rules, and the EPA's refrigerant management rule, finalized in October 2024, is eligible for a joint resolution of disapproval. However, industry stakeholders remain engaged in defending AIM Act implementation, concerned that any federal rollback of HFC standards could result in a regulatory landscape fragmented by disparate state-level actions. The U.S. Senate must act on the refrigerant management joint resolution by early May 2025, per the terms of the Congressional Review Act. At the time of writing, the joint resolution's prospects appear to be dimming, although late action as the deadline approaches cannot be ruled out. Internationally, the United States remains a party to the Kigali Amendment to the Montreal Protocol, whose global phase down in HFC production and consumption is implemented domestically by the AIM Act. The Kigali Amendment, along with the Montreal Protocol, includes a provision prohibiting trade with non-parties after 2032, meaning unilateral withdrawal could result in calamitous economic consequences for American manufacturers and consumers and, as such, is considered unlikely.

However, ongoing tensions with China over its classification as a developing country risks impacting U.S. financial contributions to the Montreal Protocol's financial mechanism, the Multilateral Fund (MLF), which supports demonstration projects for next-generation refrigerant technologies in a growing number of developing countries. Historically, many of these projects have occurred in China, raising the possibility that the United States will suspend its support so long as China is a potential beneficiary of MLF funds.

In sum, despite the broad swath of authority under the AIM Act to advance key LRM policies at the federal level, it is all but certain that the EPA will not exercise that authority under the current administration. This leaves action at the state level, which is promising notwithstanding industry concerns over fragmentation. But outside of California and New York, given typical state implementation timelines, new LRM-based requirements in other states are unlikely to take effect until closer to the end of the decade.

This leaves private sector leadership, particularly among large end users of refrigerants in such sectors as tech, data centers, commercial real estate, and large retail. Intermediate-term voluntary commitments in the private sector that demonstrate the economic and environmental benefits of LRM can serve as a powerful precursor to a future national regime in the 2030s.

Key Action Items

The overarching takeaway from the conference was that expanding LRM actions will require a collaborative, multi-faceted effort—much like a "team sport." This necessitates unprecedented collaboration among policymakers, industry leaders, advocacy groups, and academic institutions and a coordinated roadmap these stakeholders can follow to make this monumental climate opportunity a reality. Below is a summary of critical action items that we encourage the refrigerant ecosystem to prioritize moving forward.

1. Integrating LRM into Industry Operations

1. **Align LRM with existing climate, energy efficiency, circularity, safety, and ESG goals:**
    a. Embed LRM into corporate strategies to enhance visibility and accountability and align LRM with broader GHG reduction and net-zero strategies.
    b. Ensure footprints and reporting include the full suite of emissions associated with refrigerants, including stockpiles, ozone-depleting substances, and HFCs from Scope 1, 2, and 3 emissions.
    c. Showcase climate and health and safety benefits from LRM actions.
2. **Streamline and enhance data tracking and reporting processes for system owners and operators:**
    a. Encourage a private sector-led initiative to develop a flexible digital infrastructure to connect enterprise tracking tools with regulatory reporting standards.
    b. Improve the existing standardized refrigerant inventory systems by expanding the usage of tools like EPA's Portfolio Manager and Fexa's Trakref to build “living” refrigerant inventories.
    c. Equip facility leaders with compliance-informed workflows and better data.
3. **Build up from pilot initiatives:**
    a. Start by identifying and implementing LRM solutions such as leak prevention that offer the fastest financial and environmental returns for end-users.
    b. Demonstrate feasibility by launching pilot initiatives in leadership sectors such as higher education and in sectors that have already established advanced practices and significant momentum in LRM such as food retail.
4. **Build the business case and develop decision-making tools:**
    a. Create financial models, cost curves, and case studies for stakeholders to understand LRM's value and business benefits.

   b. Gather data to demonstrate cost savings and strategic advantage of LRM from a range of sectors.
   c. Encourage the development and industry utilization of financial calculators that estimate internal rate of return (IRR), net present value (NPV), and payback periods for LRM interventions—especially leak detection, recovery, and switching to reclaimed refrigerants.
   d. Make LRM visible in financial reports and balance sheets.
5. **Invest in workforce training and enhance technician certification:**
   a. Require periodic recertification for technicians under Section 608 of the Clean Air Act to ensure compliance with evolving standards.
6. **Continuously monitor progress and adapt:**
   a. Regularly evaluate LRM strategies and adapt them based on emerging challenges, new technologies, changing regulations, and/or opportunities.
7. **Raise awareness about LRM and continue to convene and share best practice:**
   a. Use creative marketing to raise awareness and simplify technical knowledge about LRM through accessible narratives that drive action, such as one-page action plans, fact-sheets, infographics, explainer videos, etc.
   b. Convene and connect stakeholders to promote industry-wide collaboration and dialogue, building on the momentum generated by the conference.

2. Filling Critical Data Gaps

1. **Conduct new research and improve data collection:**
   a. Improve data collection on refrigerant stockpiles and leak rates during transportation.
   b. Publish research findings in peer-reviewed journals for reference by global regulatory bodies like the Montreal Protocol's Technology and Economic Assessment Panel.
   c. Improve reporting of the quantity of refrigerant left in equipment at the end-of-life (by gas and equipment type).
   d. Develop simple digital tracking systems (e.g., applications with a QR code) for contractors and establish electronic reporting systems.
   e. Conduct lab scale, life-cycle analysis, and field studies comparing the performance and price of reclaimed vs. virgin refrigerants. Validate results in real-world settings with industry partners (e.g., grocery stores, real estate companies).
   f. Generate an industry-wide set of product category rules (PCR) to enable comparability.
   g. Assess health and safety concerns associated with leftover refrigerants.

3. Leveraging Voluntary Standards and Procurement Policies

1. **Improve corporate GHG reporting standards:**
    a. Address the weak HFC and optional ODS reporting requirements within key GHG reporting standards such as the GHG Protocol.
    b. Encourage more consistency in the use of GWP 20-year vs GWP 100-year time horizons for F-gases, establishing more consistent use of different GWP time horizons.
2. **Encourage greater action by procurers:**
    a. Develop LRM purchasing policy guidance and specifications, provide training and pilot procurement actions for new and existing contracts, including service as well as equipment.
    b. Push for ambitious changes to existing public and private procurement specifications for refrigerants, equipment, and servicing to prioritize the integration of LRM principles into purchasing decisions.
    c. Suggest measures that procurers can implement to achieve both cost efficiencies and reductions in greenhouse gas emissions.
3. **Engage with green building standards, labels, and recognition programs:**
    a. Engage with standards bodies and provide data and case studies to direct more action towards LRM.
    b. Raise the profile of LRM by organizing workshops at convenings like USGBC's GreenBuild conference.
    c. Update building codes at an increased pace to enable low GWP alternatives and promote reclamation, following the example of various states already working on this.
    d. Build a new ISO management standard for LRM, given that this is largely a management issue. Doing so will provide a way for stakeholders to recognize and reward good practices.
    e. Build an "Energy Star" equivalent recognition and/or labelling program for technicians, gases, services, or equipment.
    f. Correct estimates of available refrigerants and potential emissions from stockpiled and banked refrigerants in the EPA Vintaging Model.
4. **Improve recognition of LRM within sustainability ratings, shareholder activism, and related ESG engagement programs:**
    a. Encourage shareholder activists and ESG rating agencies to monitor companies' performance on LRM.
    b. Develop LRM fact sheets, indicators, and questions that should be included in ESG survey tools, ratings, and other mechanisms by which companies are rated on their sustainability performance.

4. Unlocking More Financing for LRM

1. **Leverage utility rebate and Green Bank programs for LRM:**
    a. Target sectors with high electricity costs due to inefficiency and emissions to showcase that they are overpaying.
    b. Use utility rebates as a tool for rewarding LRM.
    c. Leverage diverse capital sources—including state green banks, sovereign wealth funds, multilateral investment banks, and loan programs—to secure initial funding and finance infrastructure and equipment upgrades.
2. **Help to build rigorous carbon markets:**
    a. Combat disillusionment with carbon credits to attract more project developers and buyers of credits to support high-quality projects that mitigate F-Gases and enable LRM.

5. Driving Policy Actions

1. **Harmonize approaches across states via model policy development:**
    a. Based on the experience of states who have adopted LRM such as California, develop a model policy that other states can use as a starting point.
2. **Incentivize reclamation through workforce development, procurement policy, and markets:**
    a. Implement performance-based incentives for HVACR contractors and technicians to enhance refrigerant reclamation rates.
    b. Align state training programs with national certification standards to ensure technicians are equipped for evolving LRM requirements.
    c. Utilize carbon markets (e.g., California's cap-and-trade program).
    d. Require the use of reclaimed refrigerants in public sector systems, mirroring policies under consideration in Washington state.
3. **Engage in international policy and collaboration actions:**
    a. Learn from successful refrigerant recovery programs in other countries (e.g. Australia, Japan, and Norway, Vietnam) and engage end-users and industry to demand better LRM practices.
    b. Explore the potential for including LRM in more countries' Nationally Determined Contributions (NDCs).
    c. Participate and share tools to advance LRM in Meetings of the Parties to the Montreal Protocol and at industry events.