Refrigeration Systems: Leak Detection and Reduction
Speakers:

**Kersey Manliclic**, GreenChill Program Manager, Environmental Protection Agency

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OEM Panel:

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**Clay Rohrer**, Director, Connected Solutions, Hussmann Corporation
Refrigeration Leaks

Why do we care?
The AIM Act & The Kigali Amendment

- Phase down consumption and production of HFCs

- 2011-2013 baseline:
  - 2022: 10% reduction
  - 2024: 40% reduction
  - 2029: 70% reduction
  - 2034: 80% reduction
  - 2036: 85% reduction
California Air Resources Board (CARB) & EPA AIM Act

CARB compliance requires long-term planning, so does the AIM Act. How will you reduce your GWP footprint over 15 years?

- Refrigerant Management Regulations
  - Leak limits
  - End-of-life recovery for re-use
    - Reclaim
    - Recycle

- Sector-based controls
  - SNAP Rules 20 & 21
  - 150 GWP Limit in 2022
  - GWP footprint reduction
    - Charge size reduction
    - Retrofit to lower GWP
    - Low GWP for new equipment
Sector-based Controls

Regulations limiting hydrofluorocarbon (HFC) use for a specific family of products such as remote condensing units

- Global warming potential (GWP) limits
- HFC or refrigerant blend bans
  - Significant New Alternatives Policy (SNAP) Program Rules 20 & 21
  - AHRI Petitions
Allocations

• What are allocations?
• Who gets to make the rules re: how allocations are used?
• What do allocations mean for retailers and original equipment manufacturers (OEMs)?
The HFC allocation phase-down is designed to create an economic supply imbalance with demand

Reduced Supply Economics

• Scarcity
• Increased Prices
European Impact: Retailers and OEMs

- The Cooling Post 2020
Without Regulations

If there were no regulations, HFC demand would continue to grow.
How do we proceed with an orderly transition?
Air Conditioning 2025 & Refrigeration 2026 Don’t Balance Supply
Balancing supply and demand

Where is the additional 25% going to come from?

2024: SNAP Rules ~15% Reduction + Step 1 Petitions

2024: Allocation 40% Reduction
Reducing Demand to Balance Supply

A toolbox approach to reducing HFCs
Invest in future success now!

Toolbox

- Use low-GWP refrigerants in new equipment
- Consider smaller charge sizes
- Retrofit existing equipment, A1 -> A1
- **Reduce leaks**
- Use recovered/reclaimed refrigerant
Most significant global issue is **leaky stationary refrigeration and air conditioning** equipment.

Global: ~52% of global “GWP” is used to charge leaking equipment.

60% of the 86% = topping up leaks = 52%
Balancing supply and demand

Where is the additional 25% going to come from?
What if we could stop using new refrigerant to service equipment?
Toolbox

- Use low-GWP in new equipment
- Consider smaller charge sizes
- Retrofit existing equipment, A1 -> A1
- Reduce leaks
- Use recovered/reclaimed refrigerant
All the tools in the toolbox
EPA’s GreenChill Partnership Program

AHRI Webinar
April 26, 2022
Favorite quote…

“We’re fighting climate change while providing ice cream…”
- GreenChill Partner
Presentation Overview

- GreenChill Overview
- Current Leak Rates (%), Trends, and Partner Achievements
- Strategies & Technologies to Reduce Leaks
GreenChill is a voluntary partnership program that works collaboratively with the food retail industry to reduce refrigerant emissions and decrease stores’ impact on the ozone layer and climate system.

GreenChill works to help food retailers:
- Lower refrigerant charge sizes and eliminate leaks
- Transition to environmentally friendlier refrigerants
- Adopt green refrigeration technologies and best environmental practices
GreenChill’s Mission

GreenChill’s Mission: Reduce Refrigerant Emissions

Corporate Emissions Reductions Program
Commit
Partners measure corporate-wide emissions, set annual goals, and report annually on progress

Store Certification Program
Demonstrate
Individual stores earn GreenChill certification for meeting highest standards: low charge size, use of less harmful refrigerants, and low leak rates

Advanced Refrigeration Program
Share
Promote advanced refrigeration technologies, strategies, and practices through social media, webinars, and guidelines

Focus:
- Existing stores
- Finding leaks more quickly
- Preventing leaks from happening in the first place

Focus:
- Designing leaks out of supermarket systems
- Finding long-term solutions to leaks
GreenChill Partners Lead the Way

Newest Partner (Oct 2021!)
Certified stores demonstrate leadership in food retail refrigerant management

These stores:
- Use only non-ozone depleting refrigerants
- Have lower refrigerant charge sizes and leak rates compared to the average food retail store*

Any food retail store in the United States can apply; not necessary to be a GreenChill Partner

Platinum, Gold, and Silver certification levels

*Determines certification level.
Current Leak Rates (%), Trends, and Partner Achievements
GreenChill Partners account for 1/3 of the supermarket industry*.

**2007**
- 7 Partners
- 4,500 Stores

**2020**
- 28 Partners
- 12,900 Stores

*A GROWING SUPERMARKET PARTNERSHIP

*Food Marketing Institute Supermarket Facts (2018).*
Leak Rate – Historical

- Existing partners continue to achieve relatively lower leak rates while adding new stores.
- GreenChill has added new partners with additional stores/equipment that are improving leak rates.
Partnership Installed Refrigerants

- Profile of installed refrigerants within the Partnership has evolved over time
- Opportunities exist to further transition to lower-GWP refrigerants

![Pie chart showing refrigerant distribution in 2020](chart.png)

- **R-22** 12.3%
- **R-404A, R-407A, R-507A** 70.1%
- **R-448A, R-449A** 9.6%
- **R-744** 6.5%
- **Other** 1.5%
GreenChill Certified Stores

View the interactive map and table of certified stores
www.epa.gov/greenchill/greenchill-store-certifications

Note: Map data update in progress
Strategies & Technologies to Reduce Leaks
GreenChill Strategies to Reduce Leaks

Example Strategies from Recent GreenChill Recognition Recipients:

1. Frequent commercial rack leak checks (e.g., quarterly). Regular, manual leak prevention checks
2. Immediate notification of refrigerant leak alarms through refrigeration/energy management systems
3. Immediate repair of any identified leak
4. Multi-verification of all completed leak repairs

GreenChill Strategies to Reduce Leaks (cont.)

5. Use of remote leak detection systems
6. Use of high-quality equipment, training, and technician incentive plans
7. Supervisors frequently review leak rate reports with technicians
8. Entire store is checked if leak is > certain % threshold. Dedicate additional time to check high leak rate stores

Sources: 1) 2021 GreenChill Annual Recognition Ceremony (Meijer, Sprouts), 2) 2020 GreenChill Annual Recognition Ceremony (Weis).
Link: https://www.epa.gov/greenchill/greenchill-recognition
Updating Guidance Documents

- GreenChill team working to update more prominent technical/guidance documents (e.g., leak tightness best practices)

GreenChill Industry Resources:
https://www.epa.gov/greenchill/greenchill-industry-resources
Be a Part of GreenChill...

Corporate Emissions Reductions Program

- Request a partnership packet
- Sign the partnership agreement
- Meet eligibility requirements
- Become a GreenChill partner!

The GreenChill Partnership Process

Store Certification Program

Select the appropriate application form, complete, and submit!

Sign-up for our mailing list
Thank you!

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Driven by purpose, committed to impact

VEIC is on a mission to generate the energy solutions the world needs.

• VEIC works with organizations across the energy landscape to create immediate and lasting change
• We serve as an objective partner for our clients as they navigate complex energy challenges
• Every challenge is different, but our commitment is the same: make an impact
# Refrigeration Clients and Partners

## Utilities / States
- Distribution utilities
- Energy efficiency utilities
- Leaders across the energy industry
  - 17 states

## End Users
- Grocery chains*
- Food banks
- Food distribution companies
- Packaging plants
- Food production
- Large dairy cooperatives
- Beverage production companies, incl. breweries
- ESCOs
- Contractors

## Others
- Direct energy justice aligned customers
- Ag extension agencies
- Farmers
- Small rural businesses
- NASRC
- State Energy Offices
- Federal (DOE, EPA, etc.)
- International World Bank
- USAID

* VEIC provides energy engineering services for a chain representing 2500+ stores in the Eastern United States. We also recently expanded our scope with this client to provide transportation consulting services.
Agenda

- Utility approach for supporting refrigerant leak mitigation
- Efficiency Vermont case study
- End-user benefits of leak repair
- How to build support for leak mitigation measures
Why Refrigerant Management for Utilities?

• Utilities increasingly tasked with contributing to statewide decarbonization goals
• Refrigerants are low-hanging fruit of GHGs
• Utility heat pump programs adding significant refrigerant loads to buildings

• Refrigerants = ~4-6% of total state emissions
• Energy + non-energy savings = ideal bridge from kWh to GHG
Refrigerant Management Strategy for Utilities: Efficiency Vermont

Four-pronged approach

1. Proactive refrigerant leak detection and repair
2. Refrigerant retrofits
3. Natural refrigerant systems
4. Reduced charge size

Energy Savings calculated through OpenStudio modeling

Non-energy GHG Savings: CO2e (lbs/year) =

charge (lbs) x % leak rate x GWP
Efficiency Vermont Path to Supporting Refrigerant Management

- Pilots
  - Submetering large grocery leak repair
- Custom Projects
  - Permanent leak detection, leak audits
- Market Transformation
  - Identify barriers to proactive leak repair
Efficiency Vermont Path to Refrigerant Management, cont.

- Contractor Trainings
  - *The Art of Leak Detection and Repair*

- Prescriptive Programs
  - *Refrigerant Leak Repair for Small and Medium Businesses*

- GHG Metric
  - *Enables enhanced support of leak mitigation*
Efficiency Vermont GHG Metric:
A Gamechanger for Supporting Leak Mitigation

Integration of non-energy GHG metric

• Advocated to adopt GHG metric for refrigerant management measures
• Multi-year negotiation process with PUC for 2021-2023 performance period
• Proof of concept through pilot projects, R&D, emerging tech and informal tracking

Progress, not perfection....

• Measures must have energy AND refrigerant savings
• Refrigerant impact not included in cost-effectiveness screening
• Only approved measures can be used to claim non-energy GHG savings
  • C&I Refrigeration and HVAC
Efficiency Vermont GHG Metric:

The Evolution of an Energy Efficiency Utility

New, funded electric measures associated with Refrigerant Management Initiative in 2021-2023 DRP

1. Commercial natural refrigerant systems - rack systems

2. Replacing high GWP refrigerants with alternatives

3. Leak mitigation

4. Commercial natural refrigerant systems - condensing unit

5. Commercial kitchen equipment (freezers/refrigerators) with natural refrigerants

6. Residential refrigerator - natural refrigerants

Measures had active pilots or active research with defensible measure characterizations

Only utility doing this, but others can with MWh and/or GHG metrics

Non-energy GHG savings target for 2021-2023: 140,200 metric tons CO2e
Efficiency Vermont Highlight – Leak Detection & Repair

• 2019-2021 Impact
  • 50 projects: 25 large custom, 25 through Prescriptive Leak Repair Program
  • Total Impact/Year: 5,400,000 lbs CO2e/year (2450 metric tons)
  • MWh equivalent: 4,900
  • Average annual estimated energy savings per project: 25,000 kwh or $2,500 at $0.10/kWh
  • Average leakage rate reduction: 12%

General store in rural VT: permanent leak monitoring system prevented multiple catastrophic leaks in 2020
End-User Benefits of Leak Repair

- O&M cost reduction
- Energy savings
- Compliance
- Marketing
- Equipment reliability
- Product quality
- Environmental stewardship

• EPA GreenChill Program
Low refrigerant charges can lead to:

- Compressor short cycling
- More frequent service calls
- Equipment failures
- VEIC has metered field data correlating low charge to short cycling

Which leads to...

- Product quality concerns
- Unexpected expenses
- Decreased system/customer resiliency
Product Quality

• Less refrigerant = less heat transfer capacity to meet temperature setpoints
• Even 2 degrees of temp fluctuation can have significant impact on product quality and shelf-life
• Preventing fluctuations contributes to overall resiliency
Energy Efficiency

Low refrigerant charge can result in:*

• Increased compressor and condenser duty cycle
• Lower operating suction pressures

VEIC has meter data on condensing units that experienced refrigerant leaks

• Monitored operating pressures, box temps, system kWh to identify leak when it occurred
• Energy savings difficult to estimate in larger systems
  ❖ VEIC participating in utility M&V project
  ❖ Will wrap up in summer 2022

*Varies by system type/configuration

% increase in annual running cost

©Institute of Refrigeration Annual Conference 2013
Anecdotes from the field

“The installation of a permanent leak detection system prevented 3 separate catastrophic leak events, saving us and our customer a lot of cost and headache.” - Refrigeration Contractor

“The leakage rate in our store was so high that I was constantly worried about equipment failure. With a permanent leak detector we’ve cut our annual leakage in half.”

- National Grocery Retailer Head of HVACR
How to Build Support for Refrigerant Management Efforts

**At the Utility Level**

- Inquire about conducting a pilot through an Emerging Technology program
- Inquire through Custom Commercial/Industrial Rebate pathway
- Utilities: evaluate measures for cost-effectiveness even w/o GHG

**At the Retailer Level**

- Create value prop from list of benefits – what language do decision makers speak?
- Prioritize action by leak rates, system age, GWP, etc.
- Quantify annual material refrigerant costs to demonstrate ROI
Parallel Efforts in HVAC

Refrigerant Management Efforts Based on C&I Trends:

NYSERDA NextGEN HVAC Innovation

- Reducing leaks in heat pump systems through leak-tight installations and predictive monitoring of large commercial

Efficiency Vermont

- Equipping HVAC contractors with leak-tight toolkits and piloting value proposition/market incentives
Thank you!

Get in touch

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Winooski, Vermont
Panel: Technologies Available Today
Reducing leak rates in existing equipment
Leak detection
End User Needs / Trends

- COVID-19 Medical Refrigeration
- Changing Shopping Behavior
- Regulatory Compliance
- Energy Efficiency
- Electrification
- Reduce CO₂ Emissions

Cold Chain Dynamics Challenges and Opportunities
European Refrigerant Pricing as a Result of F-Gas Regulation

Jan 1, 2018
Zone leak detection

RLDS Multi-Zone “Active”
Aspirated systems are designed to catch leaks early and minimize refrigerant loss.

MRLDS Point Sensors “Passive”
Infrared or semiconductor-based instruments, 24/7 monitoring for safety compliance purposes

Features / Benefits
• 0–1,000 PPM detection range
• Fully integrated to BMS
• Mobile app interface for quick/easy troubleshooting and calibration
• Pre-calibrated sensors for faster installation
• Low-temperature performance

“Indirect”
• Generally uses existing sensors and HW
• Fully integrated to BMS
• Site or “cloud based
• Analyzes data (i.e., temperatures, pressures, etc.) to detect leaks

Features / Benefits
• 0–3,500 PPM detection range
• Remote sensor capabilities for flexible placement
• Analog, digital and Modbus interface for ease of integration with control devices
• Onboard relays

MRLDS-250
Infrared

MRLDS-450
Semiconductor

Infrared Aspirated Multi-Zone

Features / Benefits
• 0–10,000 PPM detection range
• Continuously monitors up to 16 separate zones
• Audible alarm and front panel indicators can trigger external alarm devices in case of fault for quick response
Best practices on leak detection

• Conduct a refrigerant inventory
  – Know what you have, where, and how much
  – Keep track of refrigerant usage
    • Good record keeping
    • Continuously update information
• Create a refrigerant management plan
  – Leak detection policy
  – Procedures in place to meet regulatory requirements
• Work toward lowering the refrigerant leak rate
  – Repair leaks
    • Quickly - do not “live with it”
    • Have a zero tolerance policy
  – Detect leaks
    • Use the available technology, fixed and hand-held leak detector
    • Conduct walk-throughs
  – Prevent leaks
    • Updated equipment
    • Track performance
    • Set company wide goals
Wayne George

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Industry Opportunities for Improvement
Safety Compliance ≠ Leak Detection

Leaks will not be found when looking for hazards

Over 99%

of recorded PPM readings are below the safety alarm level

This is not effective leak detection
Emission Reduction Solutions

Complete System enabling fast repairs > emissions reduction > cost savings
Fixed Gas Detection

- Early low-level leak detection
- 16 zones (up to 48 sample points)
- Gas library of 60+ refrigerants
Connected Solutions

- Real-time 24/7 visibility
- Remote enterprise monitoring
- Auto alarming & notification
Portable Gas Detection

- Pinpoint hard-to-find leaks
- Detect at a true 1 ppm
- Fast and simple
The Opportunity

Identify the presence of refrigerant leaks days, weeks, even months in advance of existing market solutions through the use of real-time performance data.

How does the solution work?

1. We collect & consume asset performance data
2. Apply data science to identify leak events
3. Generate actionable events, with a business case, in a technician friendly format

Solution works 24/7, behind-the-scenes, identifying leak events in real-time concretely based on data, with no human intervention.
Retailers using this system reduced overall leak rates on average by 30%, all without the addition of labor.

Example

“...the service company was dispatched and concluded that there was a cracked weld, resulting in a 60 lbs recharge... If this leak had not been discovered, it would have easily been a 300 lbs leak event... at another location, the store lost 300 lbs.”

Case Study

Plagued by leaks, this rack had a 600% annual leak rate costing in excess of $25,000 in refrigerant alone.

Impact:

Advanced refrigerant leak detection directly led to issue identification and repair verification.
Advanced Refrigerant Leak Detection

The Path & Plan


18% Emissions reduction by 2025
30% Cumulative reduction in greenhouse emissions by 2030
10% Annual reduction in refrigerant leakage by 2030
1 B Reduced or avoided metric tons of CO₂ by 2030
50% Absolute reduction in operations emissions by 2030

Steps to Success in Advanced Leak Detection

1. Assess store fleet ESG strategy and ability to achieve those shared promises
2. Create a low labor emission reduction strategy that accelerates toward goals
Questions?
Please contact us with any questions!

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