

Refrigeration Systems: Leak Detection and Reduction

Speakers:

Kersey Manliclic, GreenChill Program Manager, Environmental Protection Agency

Helen Walter-Terrinoni, VP of Regulatory Affairs, AHRI

Ali White, Energy Consultant, Engineering, Veic

OEM Panel:

Agustin Cardona Chin, Product Manager, Emerson Commercial & Residential Solutions

Wayne George, Sales Technical Support Specialist, MSA Bacharach

Clay Rohrer, Director, Connected Solutions, Hussmann Corporation

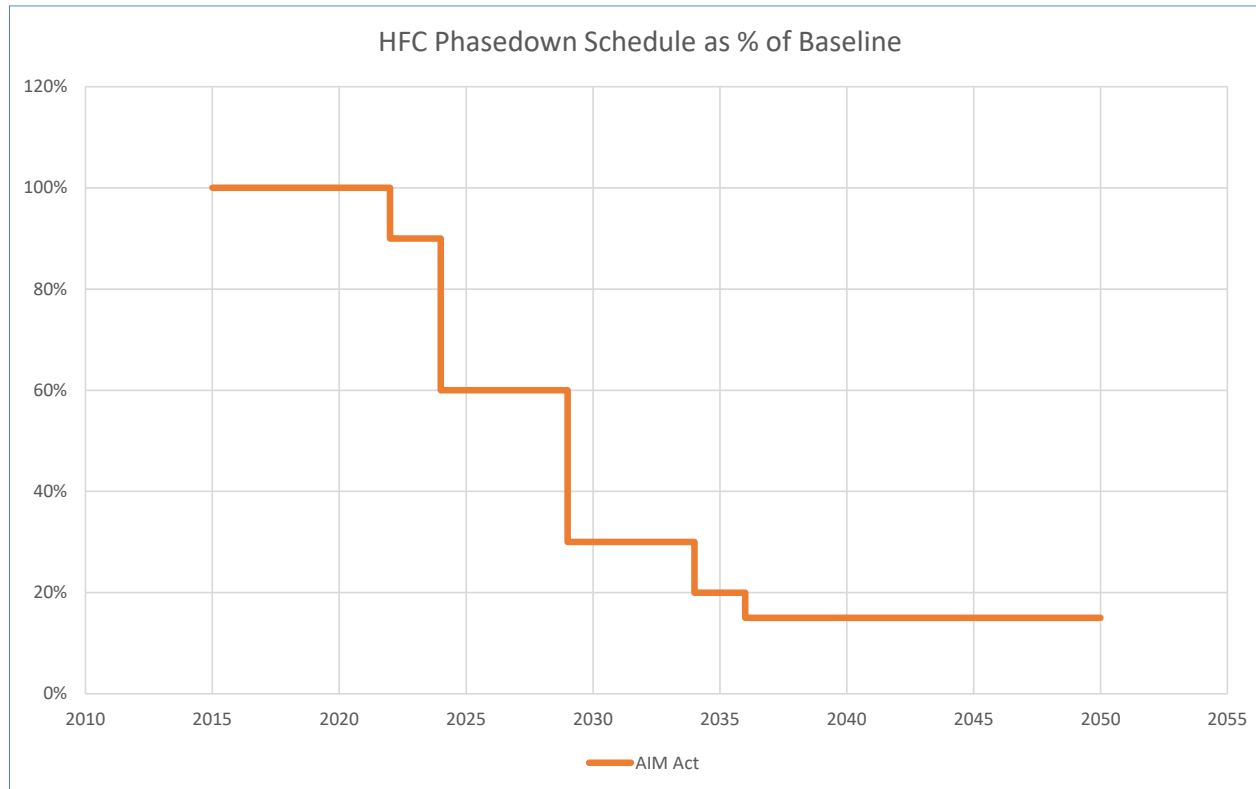


Refrigeration Leaks

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

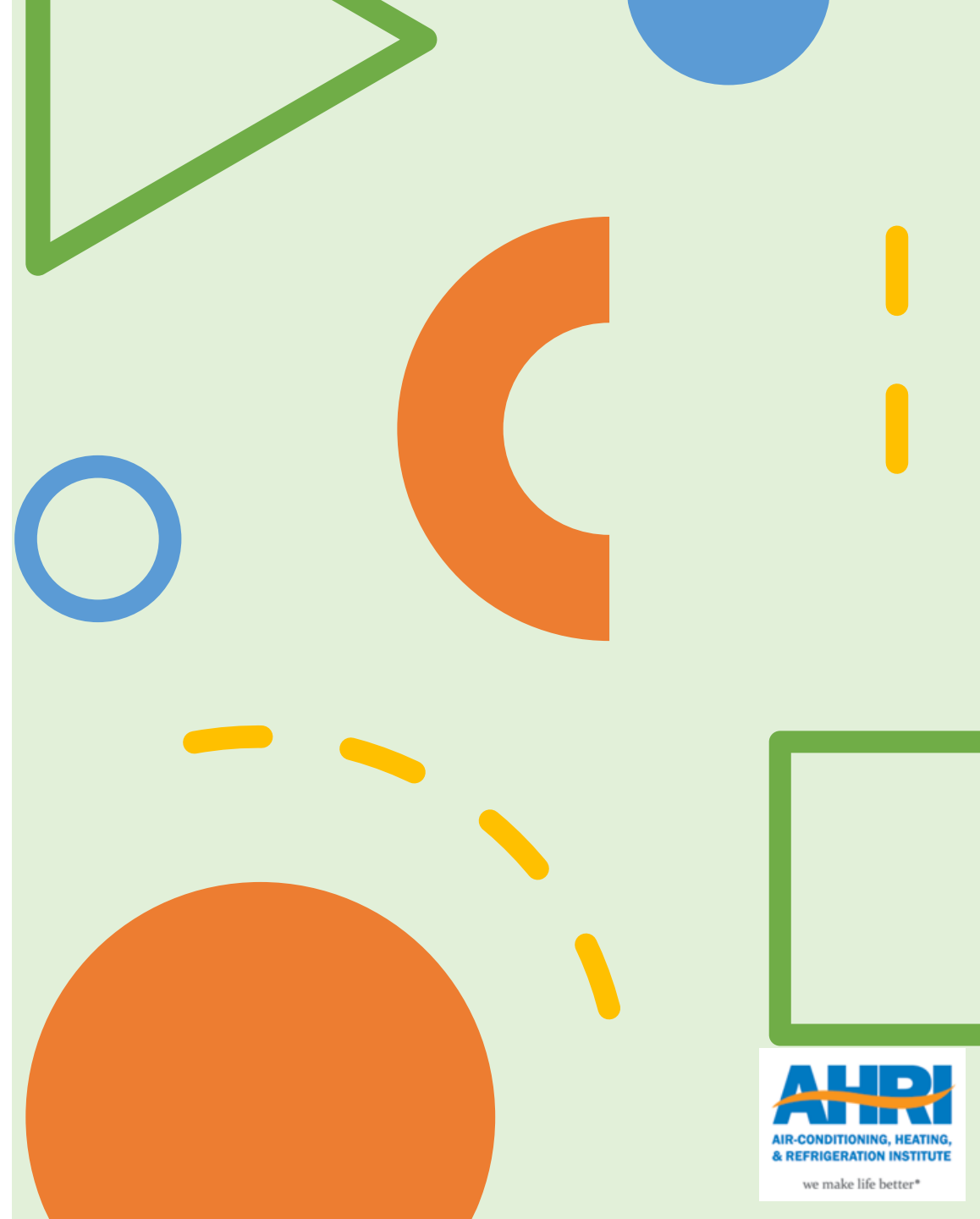
Allocations

- 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)?

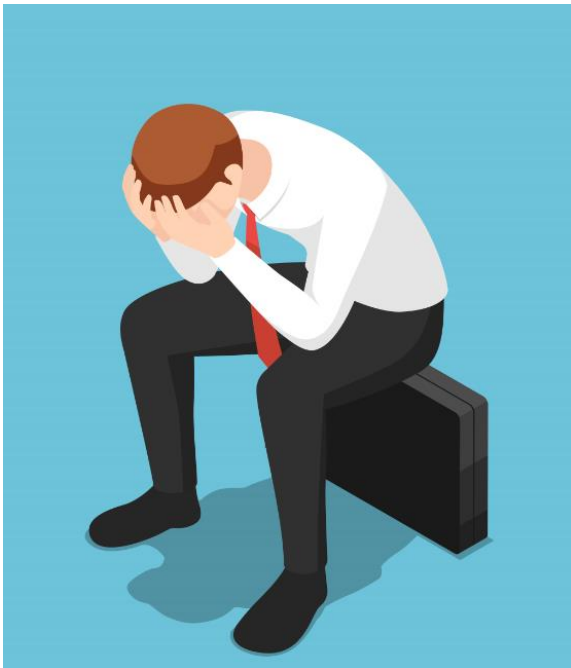
The HFC allocation phase-down
is designed to create an
economic supply imbalance
with demand

Reduced Supply Economics

- Scarcity
- Increased Prices



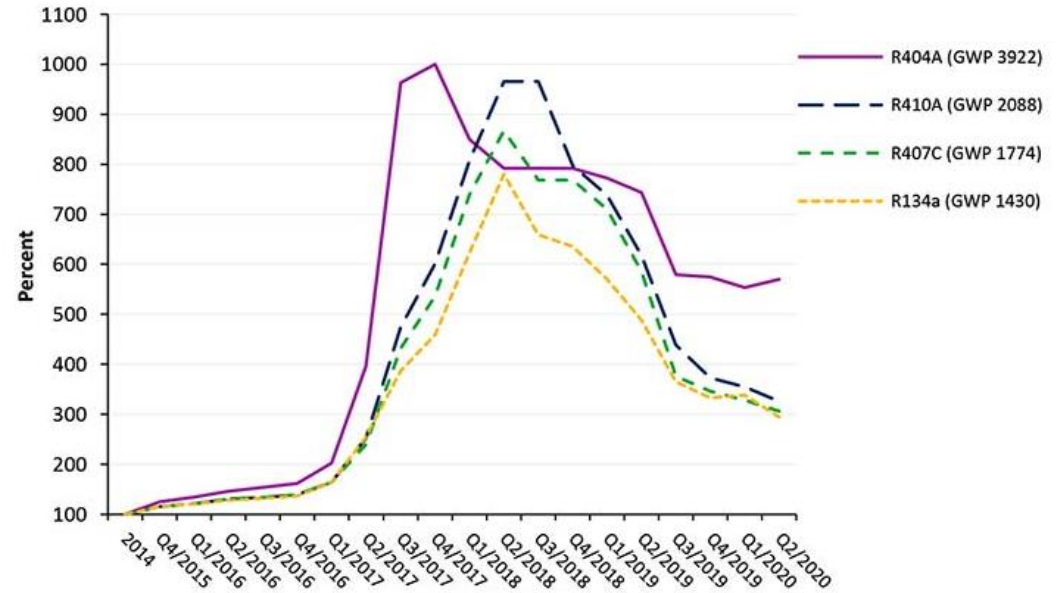
European Impact: Retailers and OEMs



- The Cooling Post 2020

Refrigerant demand and prices

29 SEP 2020



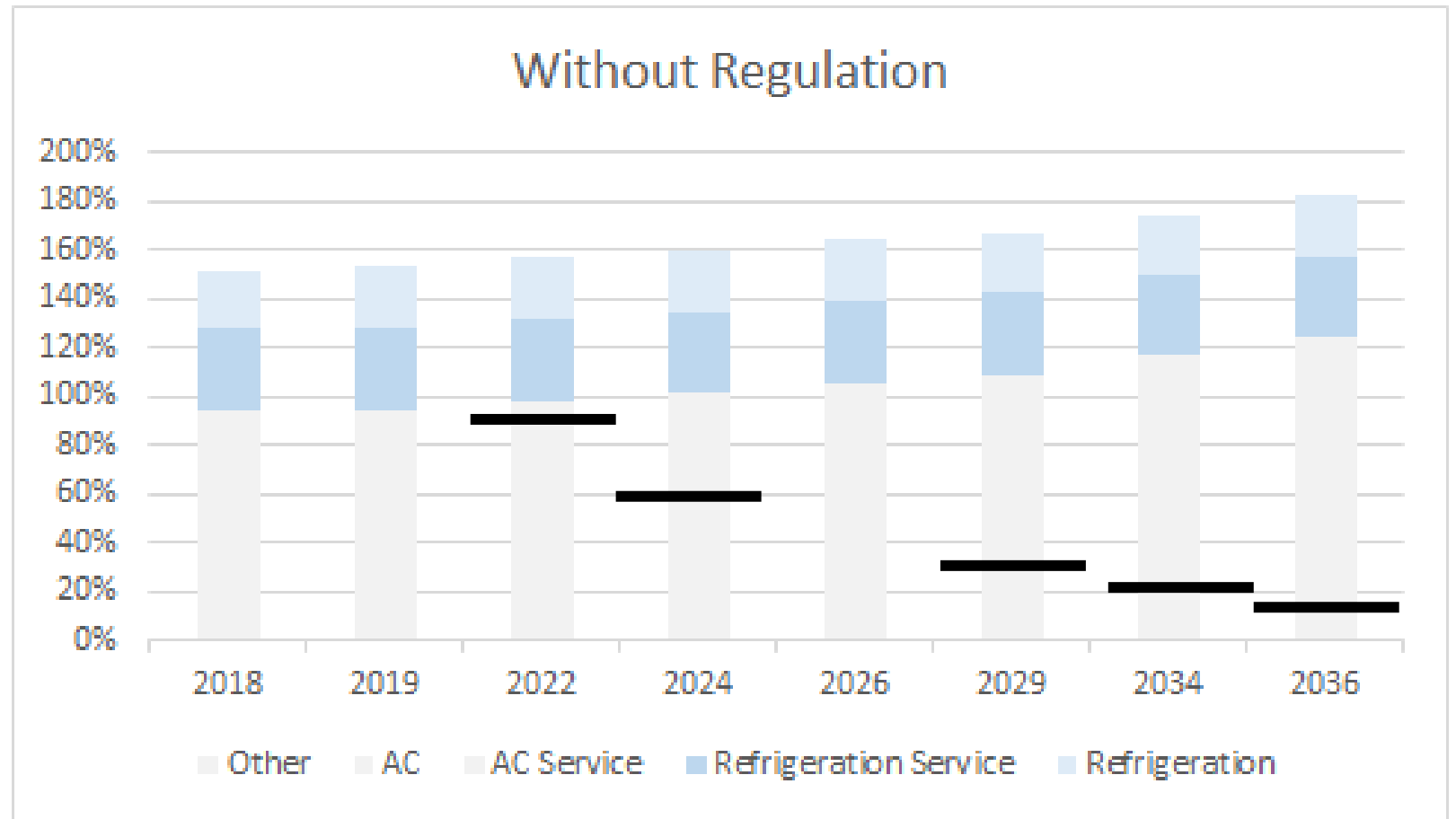
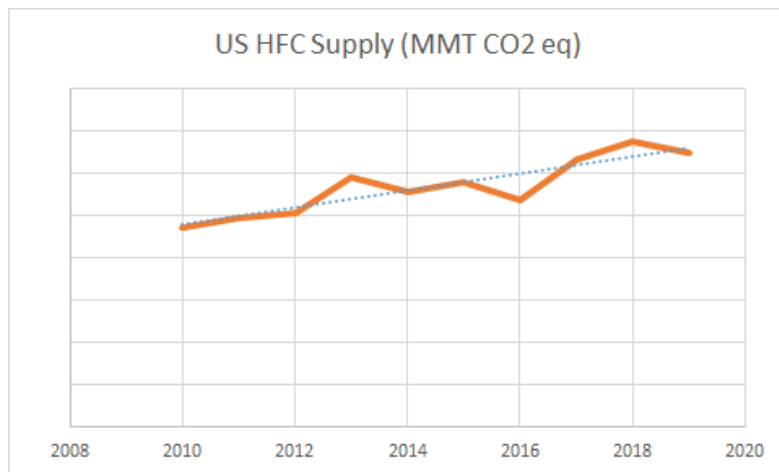
Average purchase prices reported by three large refrigerant distributors. Prices are indexed to the baseline year 2014

EUROPE: The effects of Covid-19 are held at least partly responsible for a fall in refrigerant demand and prices in the quarter to September.

The refrigerant price trends are recorded in the latest report from German consultancy Öko-Recherche.

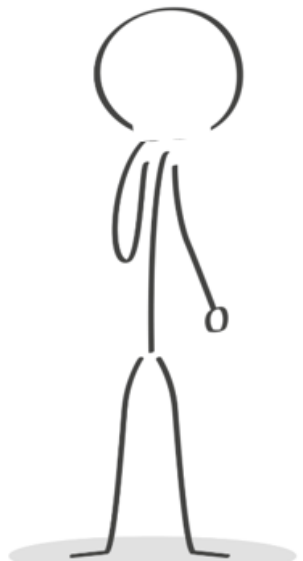
Without Regulations

If there were no regulations, HFC demand would continue to grow.

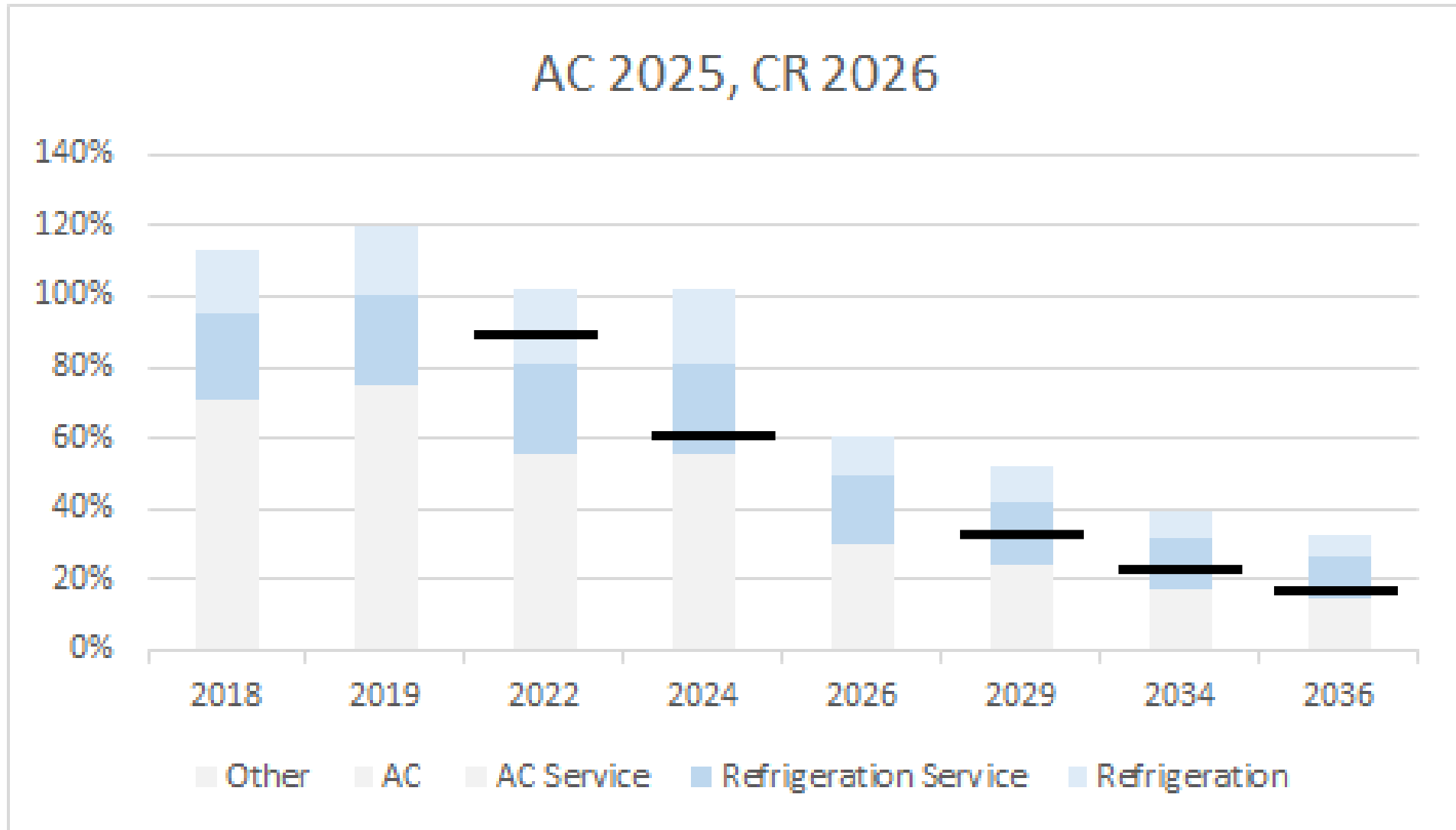




How do we proceed with an orderly transition?



Air Conditioning 2025 & Refrigeration 2026 Don't Balance Supply





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

2024: Allocation 40% Reduction

Balancing supply and demand

Where is the additional 25% going to come from?



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

United Nations Environment Program Fact Sheet

- Most significant global issue is leaky stationary refrigeration and air conditioning equipment

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

Figure 4 Markets using HFCs, % of tonnes CO₂ 2012

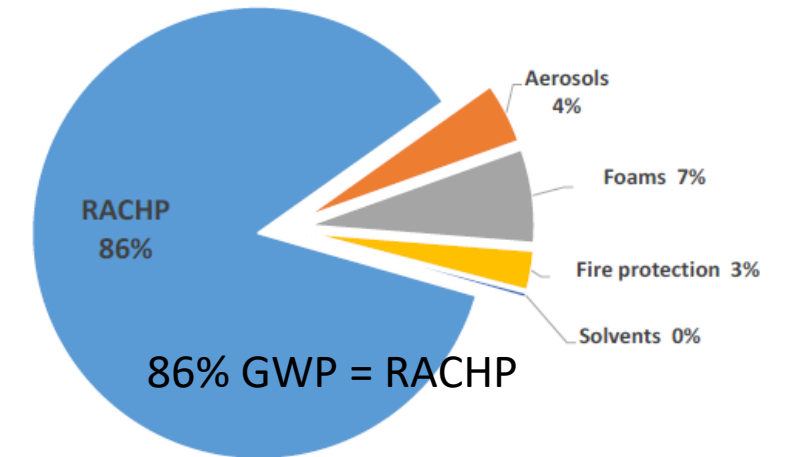
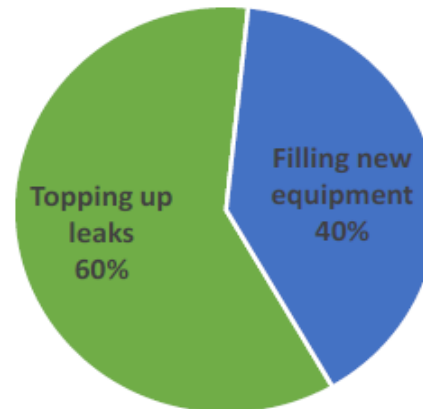


Figure 6: HFC use for topping up leaks in RACHP



60% of the 86% = topping up leaks = 52%



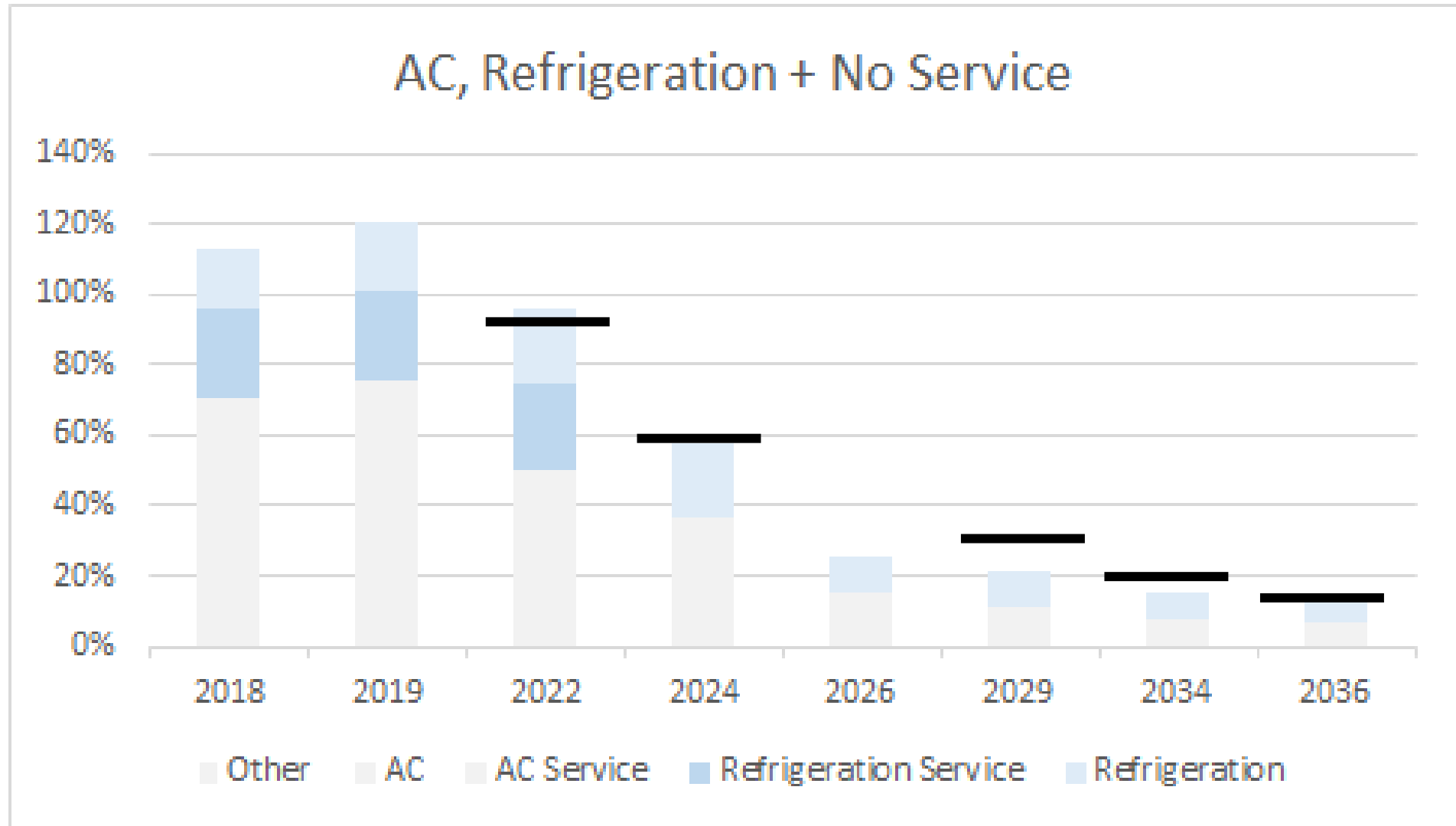
2024: SNAP Rules ~15% Reduction
+ Step 1 Petitions

2024: Allocation 40% Reduction

Balancing supply and demand

Where is the additional 25% going to come from?

What if we could stop using new refrigerant to service equipment?



Invest in future success now!

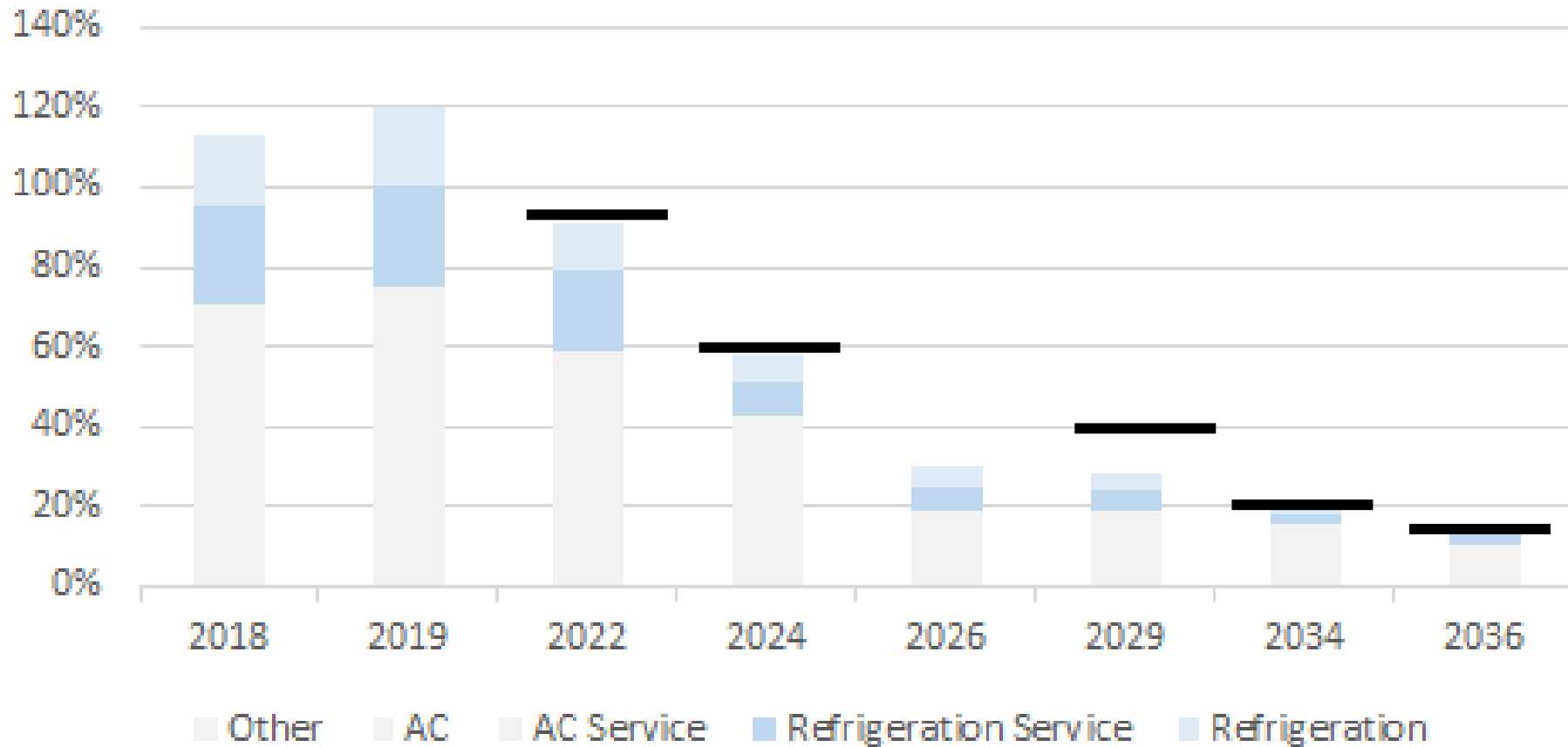
Toolbox

- Use low-GWP in new equipment
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- Reduce leaks
- Use recovered/reclaimed refrigerant

Invest in future success now!

All the tools in the toolbox

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

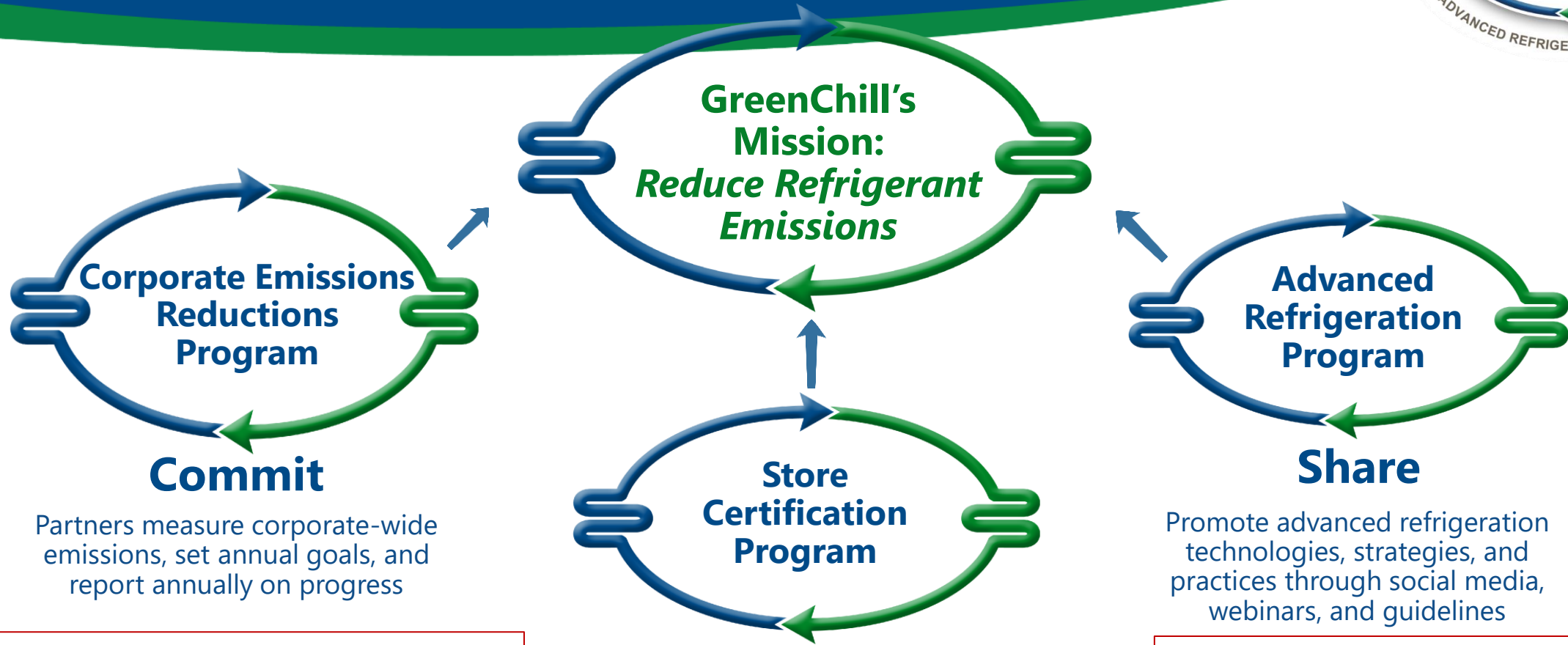


GreenChill is a voluntary partnership program that works collaboratively with the food retail industry to reduce refrigerant emissions and decrease stores' impact on the ozone layer and climate system

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



Corporate Emissions Reductions Program

Commit

Partners measure corporate-wide emissions, set annual goals, and report annually on progress

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

**GreenChill's Mission:
Reduce Refrigerant Emissions**

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:**
- Designing leaks out of supermarket systems
 - Finding long-term solutions to leaks

GreenChill Partners Lead the Way



STOP&SHOP.

Newest Partner
(Oct 2021!)

Store Certification Program



- 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



Food Retail Partners



2007

**GreenChill Partners
account for 1/3 of
the supermarket
industry***

7
Partners

4,500
Stores



2020

28
Partners

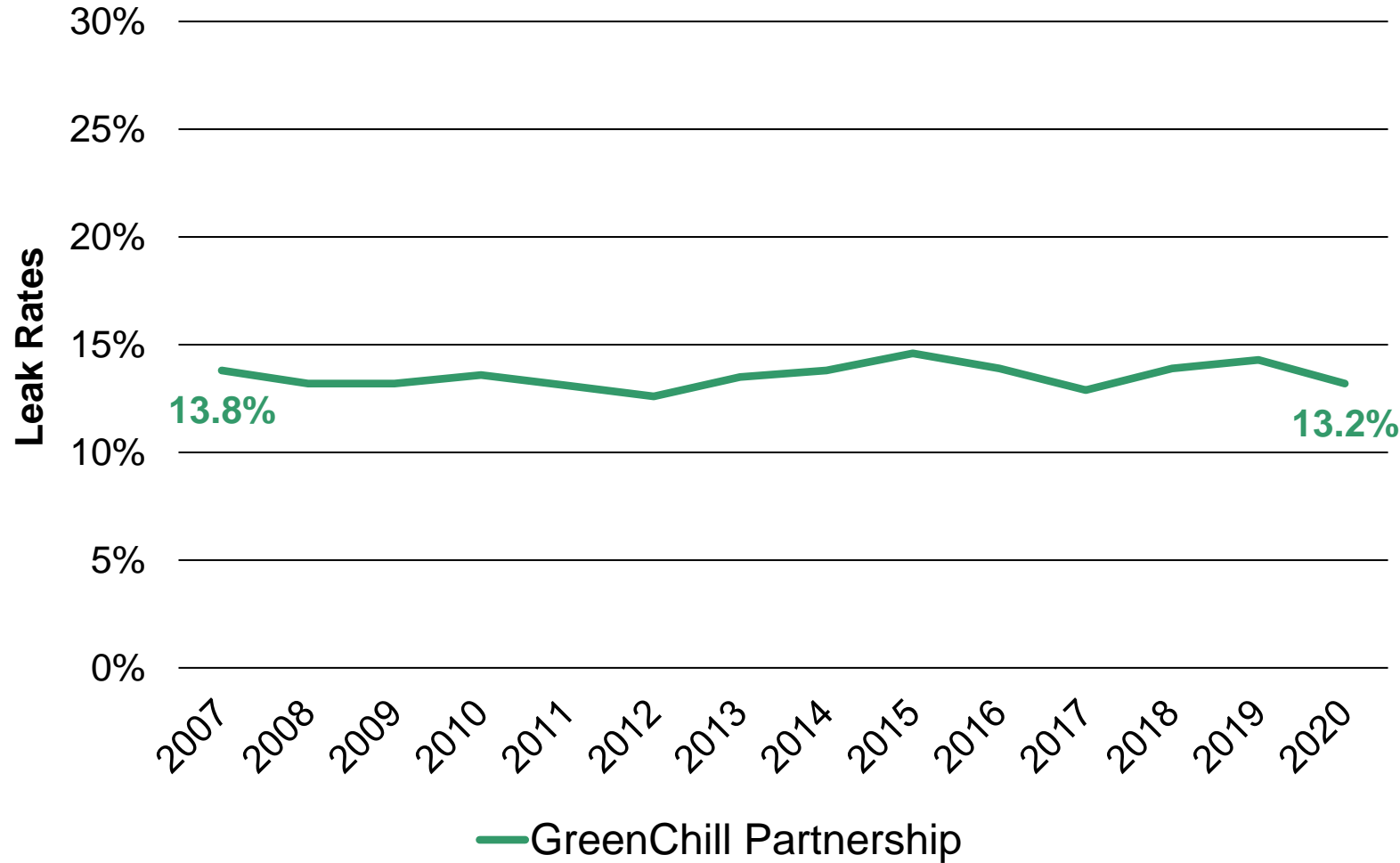
12,900
Stores

3X



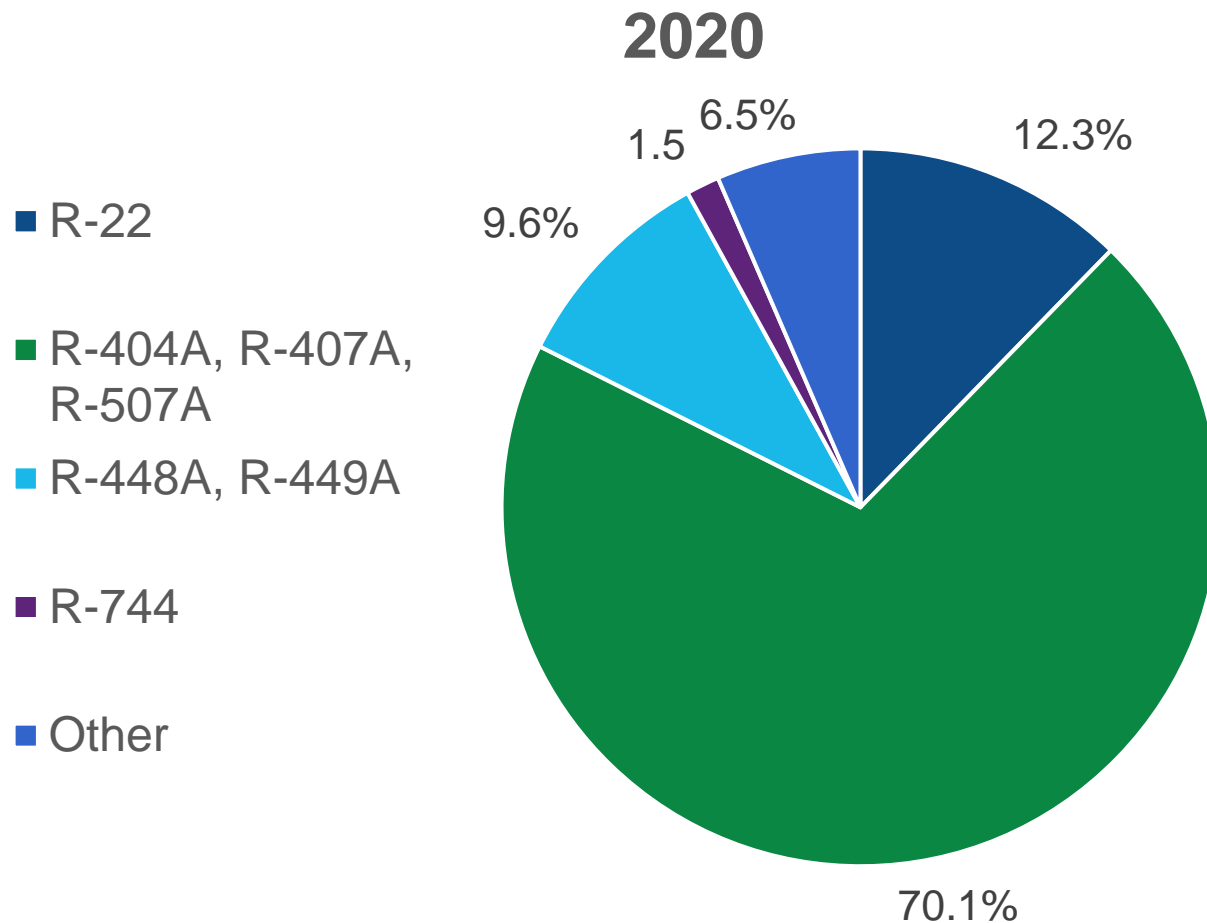
*Food Marketing Institute Supermarket Facts (2018).

Leak Rate – Historical



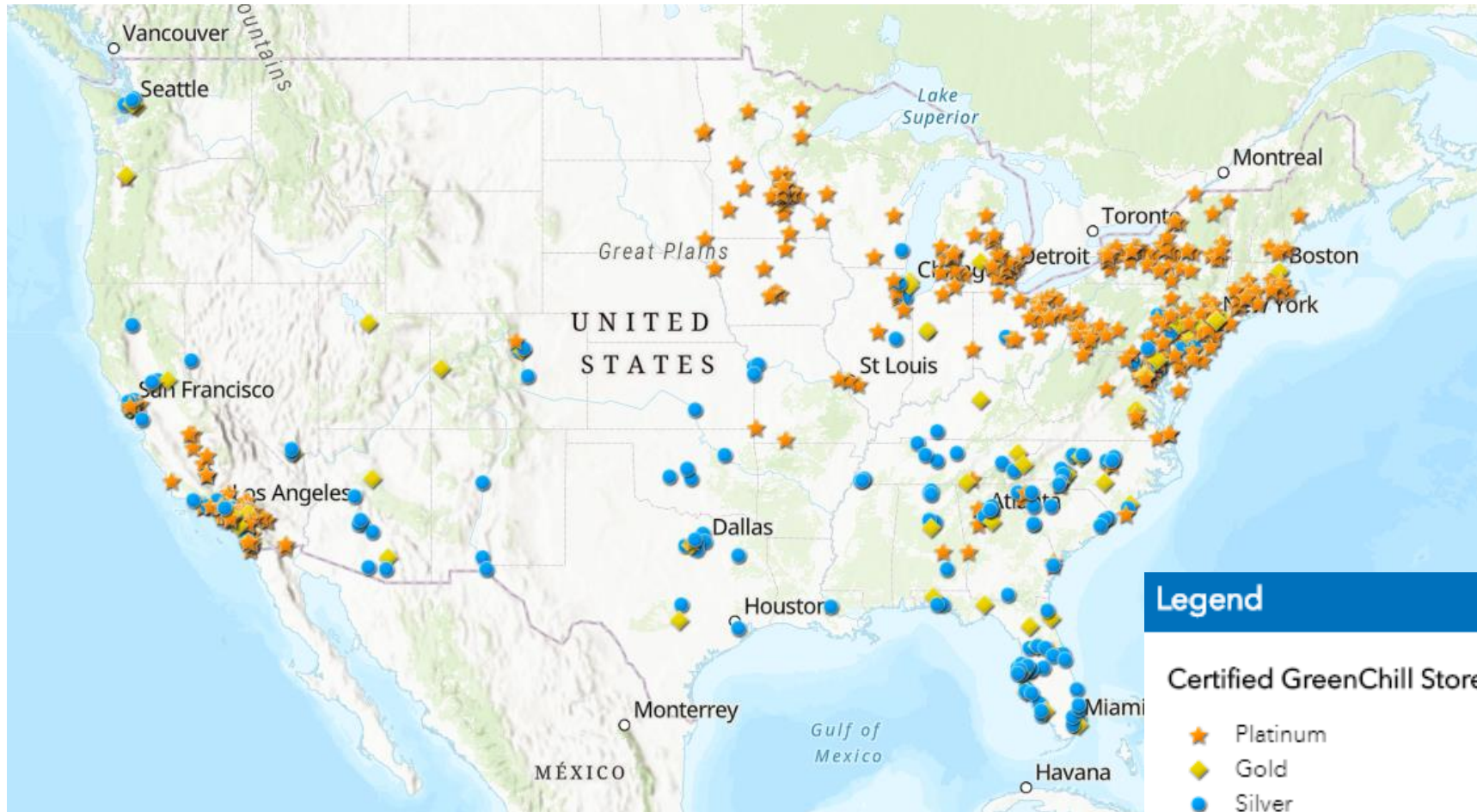
- Existing partners continue to achieve relatively lower leak rates while adding new stores
- GreenChill has added new partners with additional stores/equipment that are improving leak rates

Partnership Installed Refrigerants



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

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

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

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>

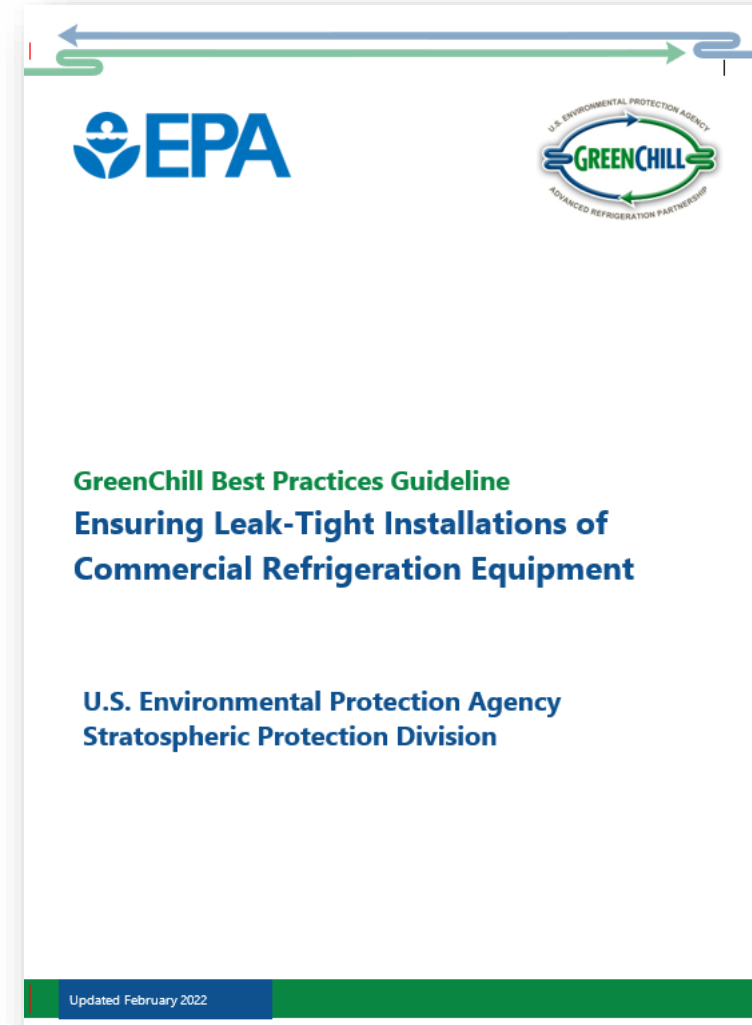
Updating Guidance Documents



- 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...



Request a partnership packet



Sign the partnership agreement



Meet eligibility requirements



Become a GreenChill partner!

The GreenChill Partnership Process



Select the appropriate application form, complete, and submit!



Sign-up for our mailing list

Thank you!



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The logo for the Virginia Environmental Infrastructure Council (veic) is located in the top left corner. It consists of the lowercase letters "veic" in a white, sans-serif font, followed by a thick orange diagonal slash mark. The background of the entire slide is a scenic aerial photograph of a lake surrounded by lush green forests and rolling hills under a soft, hazy sky. A large, curved orange graphic element is positioned on the right side of the slide.

veic /

AHRI Leak Detection and Prevention Webinar: Strategies and Benefits

04.26.2022

A small, solid orange square icon is located to the left of the speaker's name.

Ali White – Engineering Consultant, Refrigerant Management Team



**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



Efficiency
Vermont

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.



DC
SUSTAINABLE ENERGY
UTILITY

veic



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

Table 1: Global warming potential values.⁷

GHG Category	AR4 GWP Value	Atmospheric Lifetime (years)
CO ₂	1	Variable
CH ₄	25	12
N ₂ O	298	114
HFCs	124 - 14,800	1 - 270
PFCs	7,390 - 12,200	2,600 - 50,000
NF ₃	17,200	740
SF ₆	22,800	3,200

- 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

- EPA GreenChill Program

Equipment reliability

Product quality

Environmental
stewardship



Equipment Reliability

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



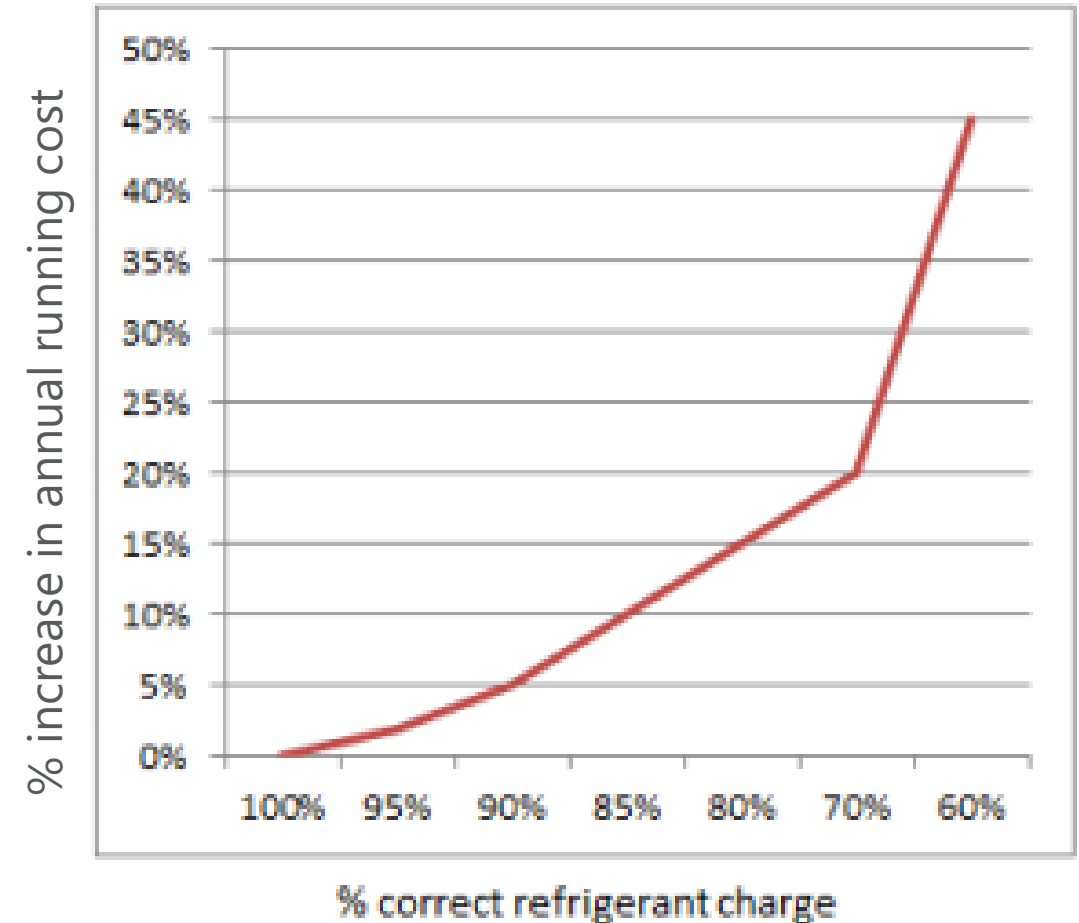
Energy Efficiency

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



©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:

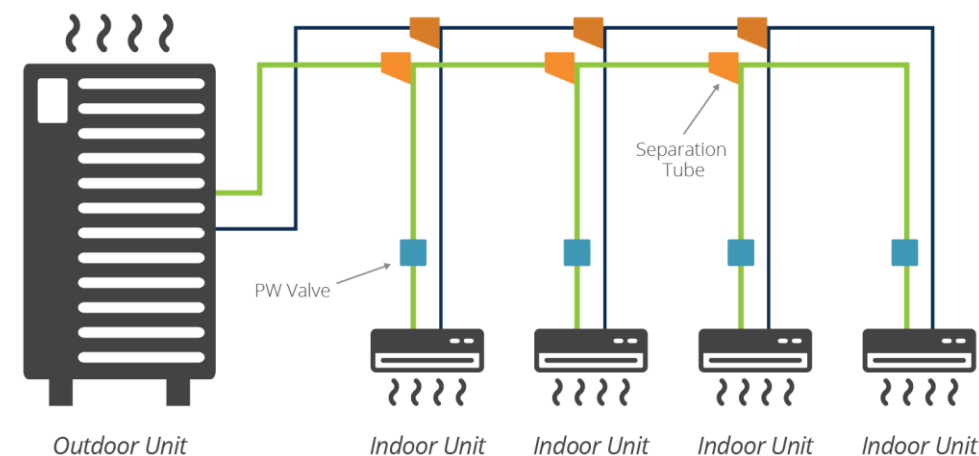
NYSERDA NextGEN HVAC Innovation

- ❖ 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

Refrigerant Piping in VRF System





Thank you!

Get in touch

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Engineering Consultant

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 **Winooski, Vermont**





Panel: Technologies Available Today

Reducing leak rates in existing equipment

Leak detection

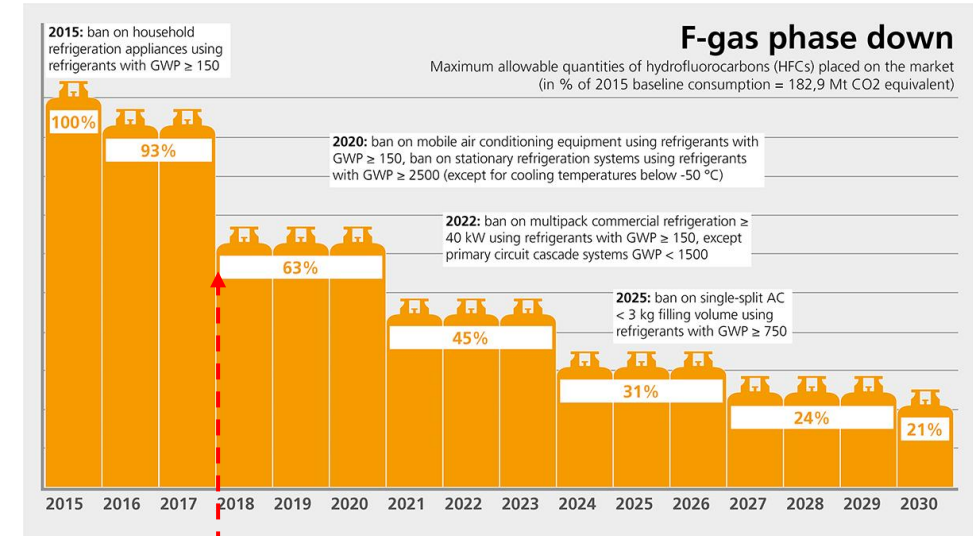
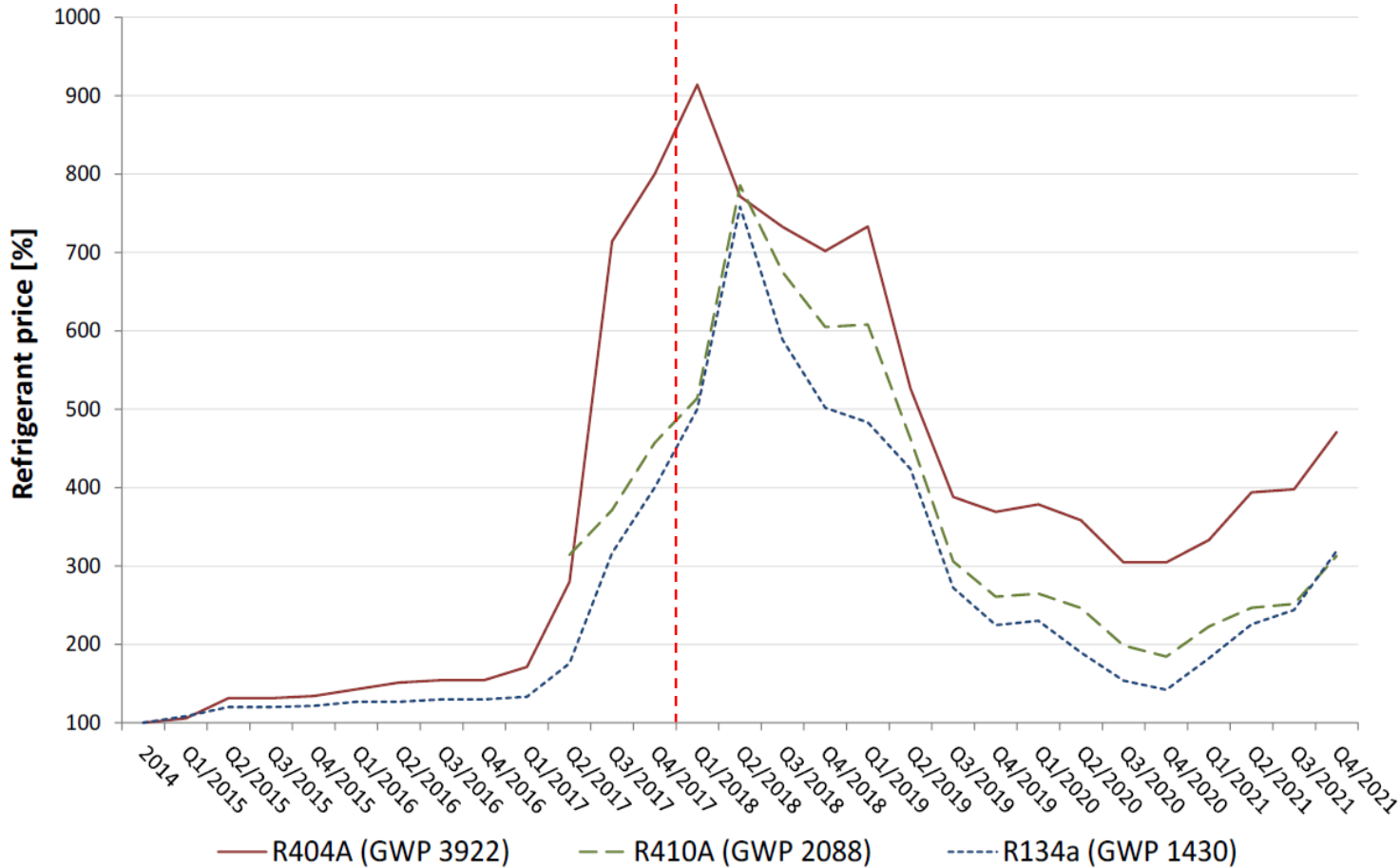
Cold Chain Dynamics Challenges and Opportunities



End User Needs / Trends



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.

RLDS



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**

MRLDS Point Sensors “Passive”

Infrared or semiconductor-based instruments, 24/7 monitoring for safety compliance purposes



MRLDS-450

Semiconductor



MRLDS-250

Infrared

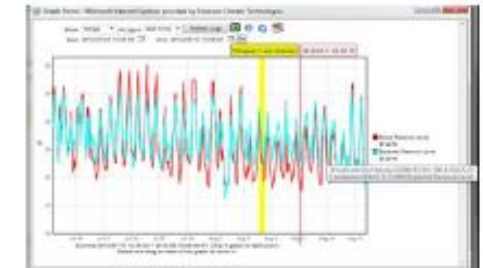
Features / Benefits

- 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

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

“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

Best practices on leak detection

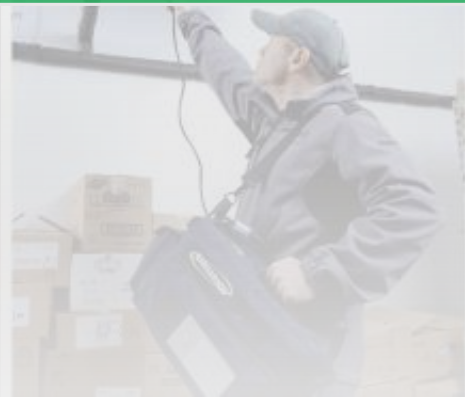
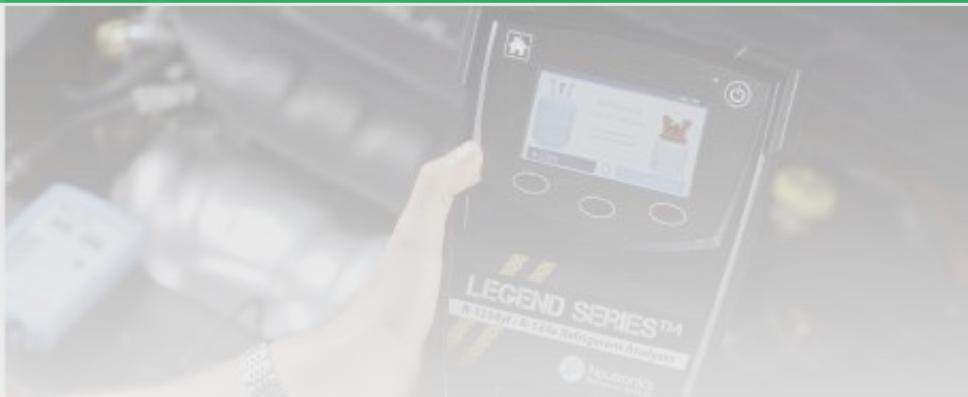
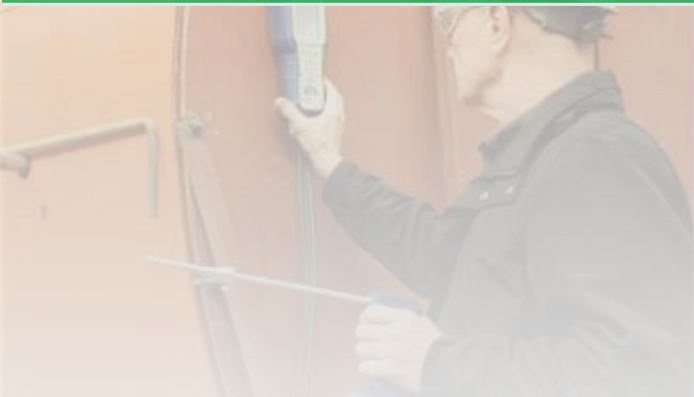
- Conduct a refrigerant inventory
 - Know what you have, where, and how much
 - Keep track of refrigerant usage
 - Good record keeping
 - Continuously update information
- Create a refrigerant management plan
 - Leak detection policy
 - Procedures in place to meet regulatory requirements
- Work toward 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

(800) 736-4666 | wayne.george@MSAsafety.com



Industry Opportunities for Improvement



SAFEGUARDING
PEOPLE, PLACES, & THE PLANET



**REDUCED
EMISSIONS**

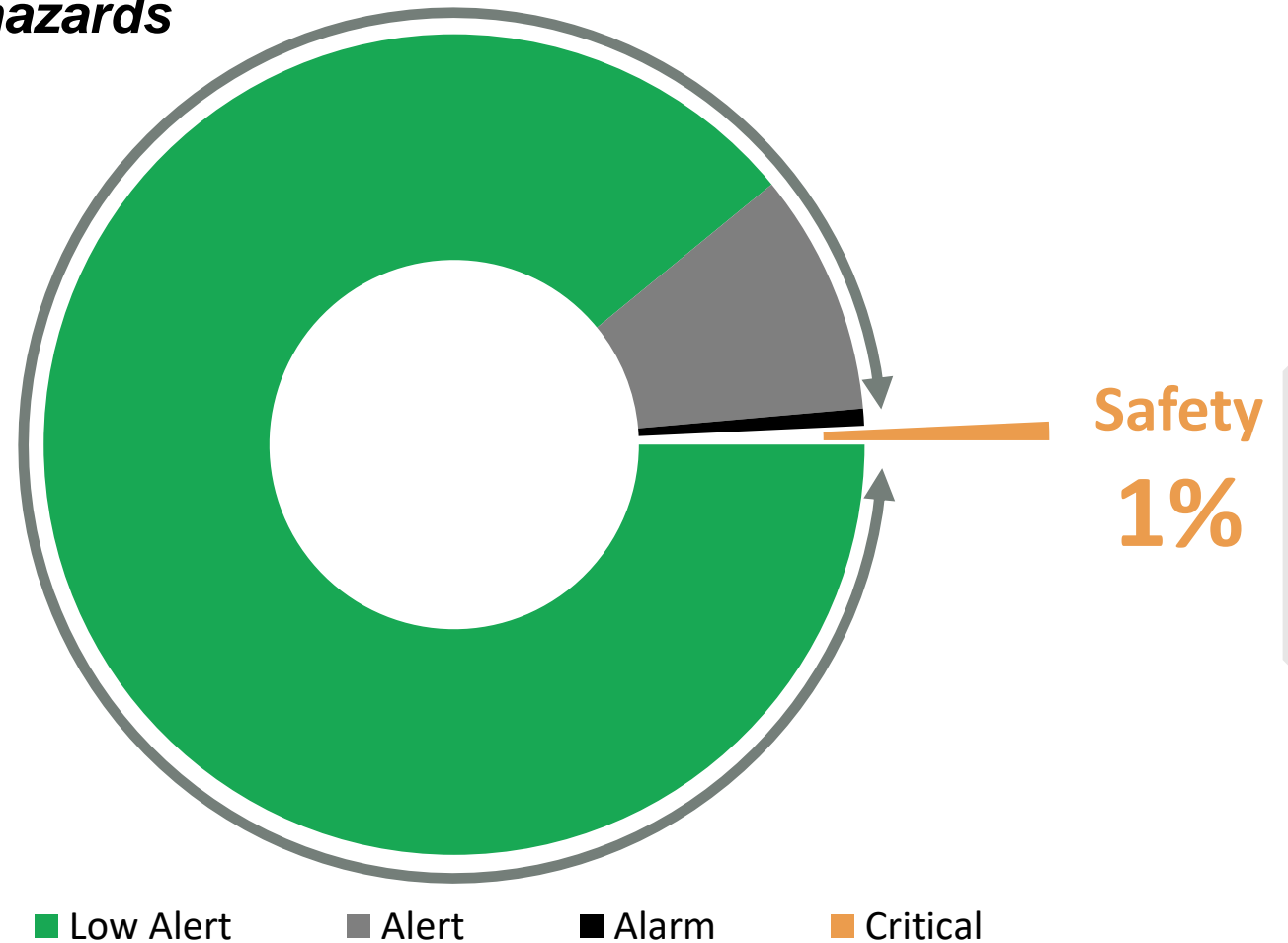
Safety Compliance ≠ Leak Detection

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

FIXED GAS DETECTION



CONNECTED MONITORING



PORTABLE GAS DETECTION

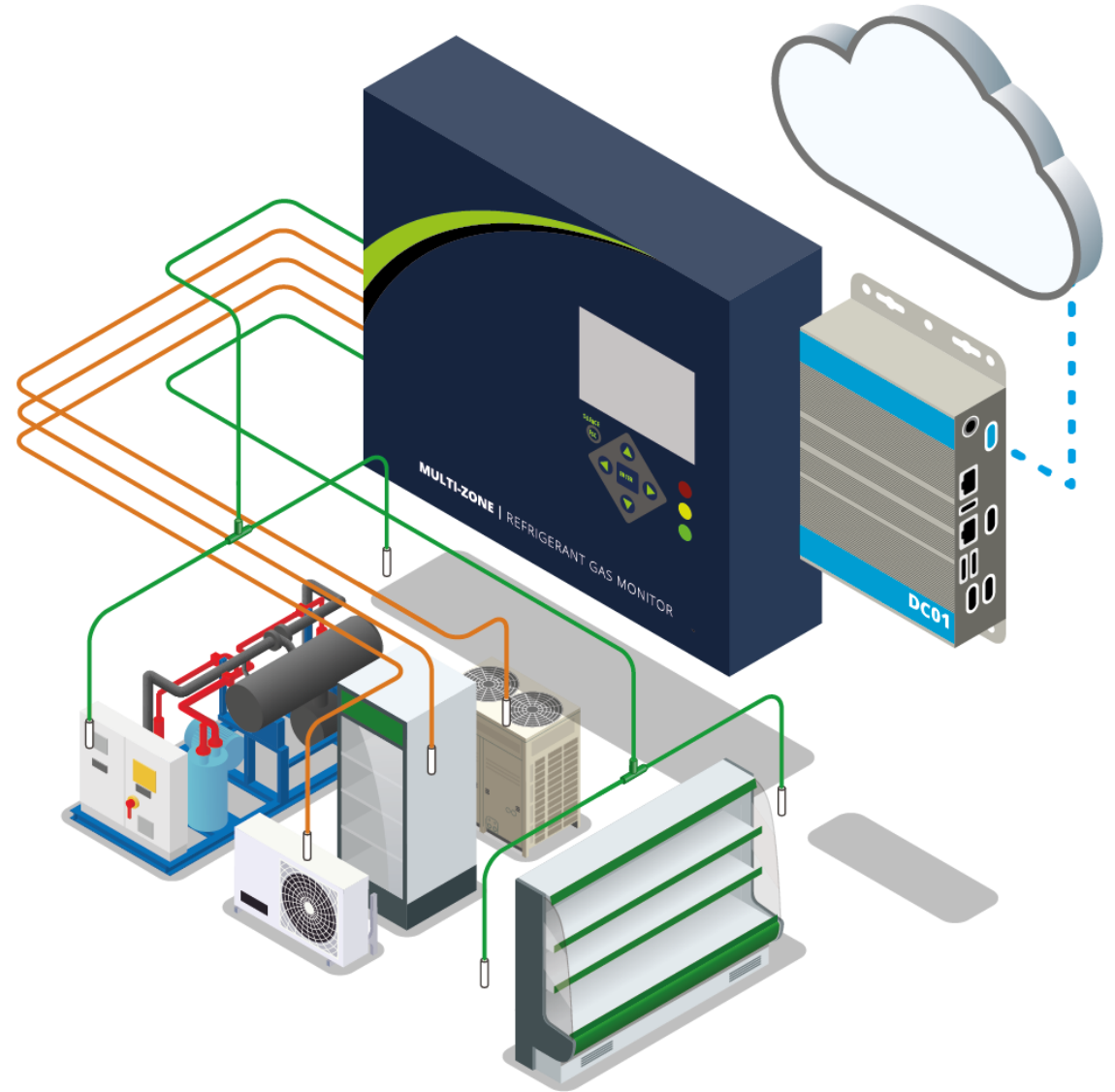


Complete System enabling fast repairs > emissions reduction > cost savings

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

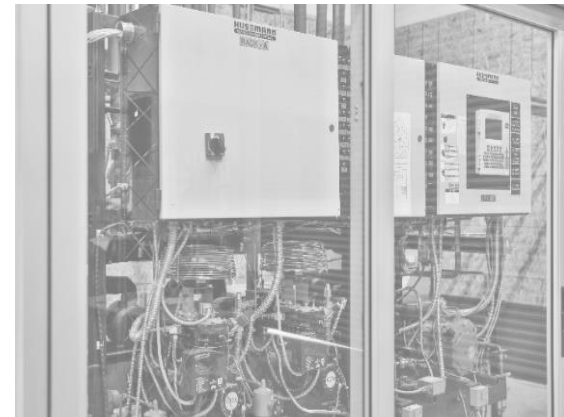


Portable Gas Detection



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

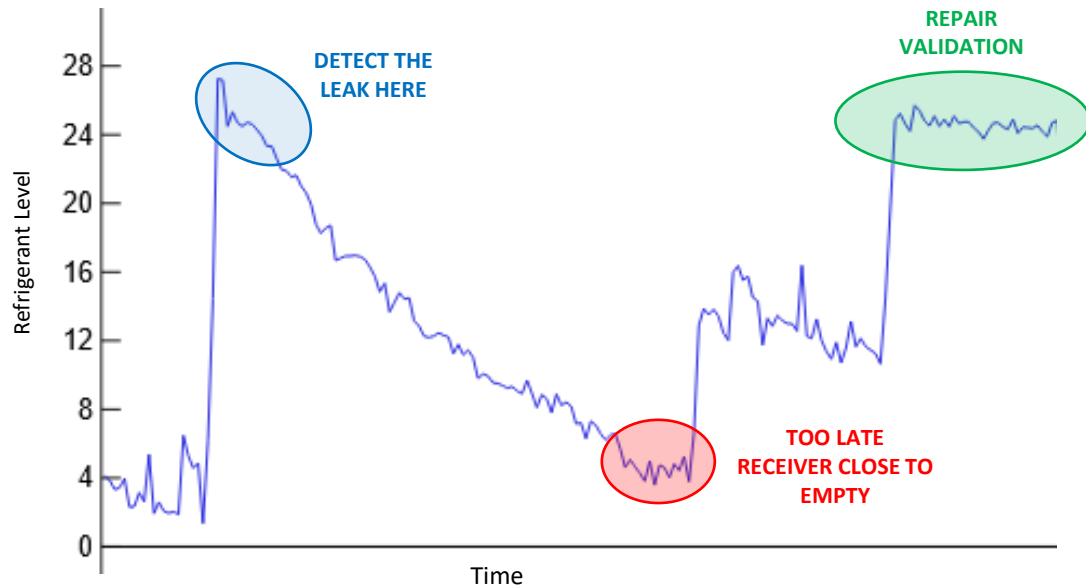




Advanced Refrigerant Leak Detection

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

Advanced Refrigerant Leak Detection

The Theory Tested

Results

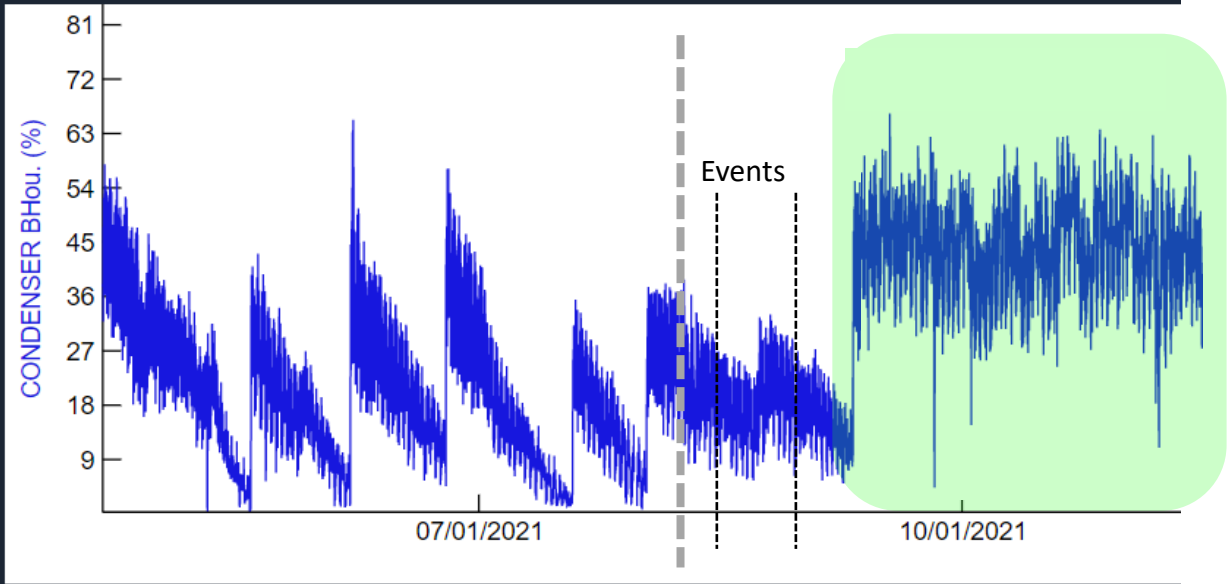
Retailers using this system reduced overall leak rates on average by 30%, all without the addition of labor.

>30%

Avg. Leak Rate Reduction

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.

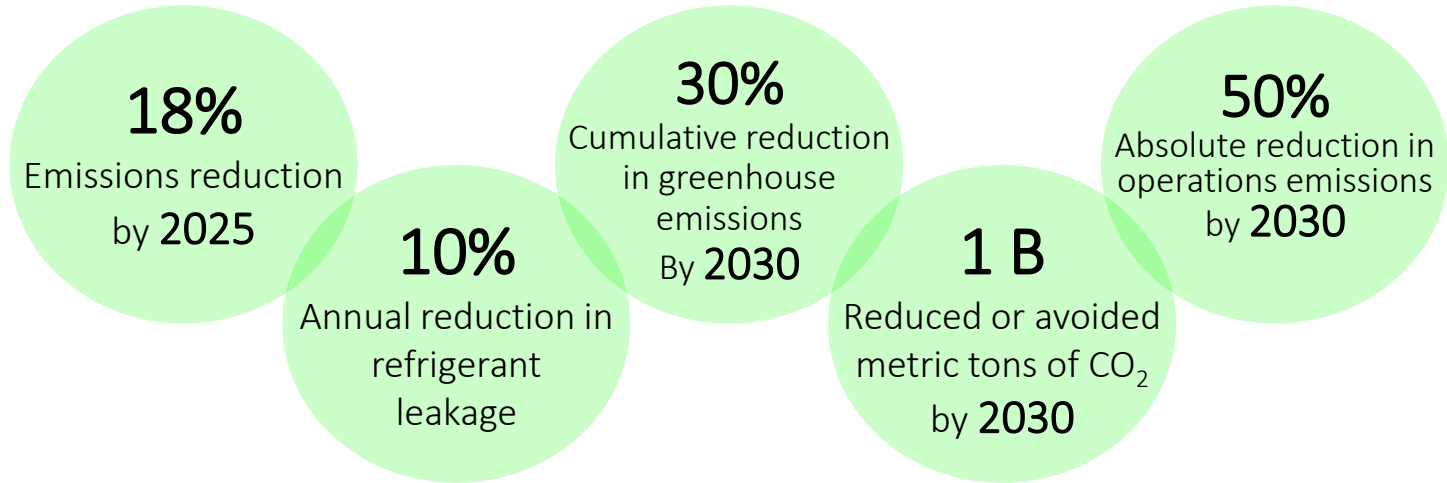
Impact:

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

Advanced Refrigerant Leak Detection

The Path & Plan

**Shared Promises. Shared Plans.
Shared Execution. Shared Results.**



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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