



C&I Refrigeration Pilot

EWR Collaborative Meeting

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Commercial & Industrial Refrigeration Pilot

- Phase 1: DTE to conduct a Market and Feasibility Study for Commercial Refrigeration Pilots
 - DTE issued an RFP for the study in May 2022 - **complete**
 - Select contractor – July 2022 – **complete**
 - Study start date – August 2022 - **complete**
 - Study completion date – December 2022 - **complete**
- Phase 2: C&I Refrigeration Pilot
 - Results from Phase 1 will inform feasibility of a pilot in 2023

Market and Feasibility Study for Commercial Refrigeration Pilot



Project Goals and Objectives

DTE elicited expert support to understand the technical and market feasibility of a pilot program focused on refrigerants with lower global warming potential (GWP) and leakage reduction opportunities for commercial refrigeration applications. Specifically, the Study will consider two key pilot topics:

- Topic 1: A drop-in refrigerant replacement program for various commercial refrigeration applications.
- Topic 2: A “find and fix” refrigerant leakage reduction program focused on small grocery and convenience stores.

Guidehouse Objective

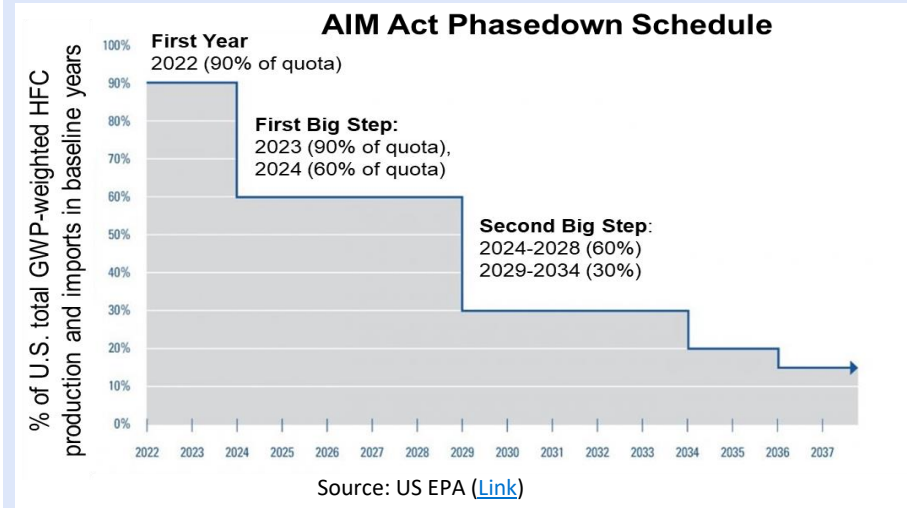
- Conduct a literature review and interview stakeholders with expertise in commercial refrigeration and refrigerants and then characterize the customer segments and product categories with potential for energy savings benefits.
- Identify potential customers eligible for the pilot program and identify the opportunities and challenges, as well as the cost effectiveness.
- Presents objective and fact-based information supporting the conclusions about whether the pilot programs would benefit DTE Electric’s customers

Background and Policy Overview

Hydrofluorocarbon (HFC) refrigerants are widely used for refrigeration applications, but their high global warming potential (GWP) causes significant greenhouse gas emissions (GHG) when released into the atmosphere.

- Commercial refrigeration systems contribute **direct and indirect emissions**.
 - **Direct emissions** are associated with refrigerant leakage during operation.
 - **Indirect emissions** are associated with the system's electricity consumption.
- **Lower GWP alternatives**, including carbon dioxide, ammonia, propane, as well as a number of lower GWP HFC and hydrofluoroolefin (HFO) blends, are emerging on the market for **both new equipment and retrofit applications**.
- Refrigeration system owners and manufacturers have developed strategies to **address system leakage through improved monitoring and maintenance practices**.
- Federal and state regulations **primarily focus on direct emissions**.
- MPSC rules limit DTE Electric's **focus on the energy efficiency (i.e., indirect emissions)**.

The American Innovation and Manufacturing (AIM) Act of 2020 enables federal regulation of HFC refrigerants based on GWP (**direct emissions**).



US EPA released a proposed rule in Dec. 2022 which outlines a **150-300 GWP limit for most commercial refrigeration sectors in 2025**.

Product and Market Segments Overview

C&I customers use a variety of refrigeration system designs to accomplish different activities including food storage, food sales, and different industrial processes.

- The technologies employed in these segments vary greatly in the system design and necessary cooling capacity, and therefore also have various ranges of refrigerant charge, leak rates, and installation practices.
- Major customer segments include grocery stores, convenience stores, restaurants, storage warehouses, hotels, and other public use buildings. Most segments also use multiple types of refrigeration systems.
- Self-contained refrigeration products with smaller charge sizes (e.g., vending machines, reach-in refrigerators and cases) are found in a wide variety of applications.
- Larger systems with greater charge size (e.g., centralized refrigeration racks, display cases with remote condensing systems) are more concentrated in food sales, cold storage, and industrial facilities.

Refrigeration System Type	Charge Size Range	Typical Leak Rates	Assembly
Centralized Refrigeration Rack Systems	200-5,000 lbs	15-30%	Field
Display Cases with Remote Condensing Systems	5-200 lbs	15%	Field
Industrial Process Refrigeration / Chillers	200-5,000 lbs	20%	Field
Walk-in Refrigerators / Freezers	20-200 lbs	15%	Field
Self-Contained / Standalone Retail Food	1-10 lbs	< 5%	Factory
Refrigerated Food Processing and Dispensing Equipment	< 2 lbs	<1 %	Factory
Refrigerated Vending Machines	< 2 lbs	<1 %	Factory
Auto Commercial Ice Makers	1-50+ lbs	<1 %	Factory (most)

The appendix provides images and other details for each system type.

Key Findings and Conclusions: “Find and Fix” Leakage Management

- Typically, larger commercial refrigeration systems have annual leak rates of 10-30% and would be applicable for leakage management projects. This would include supermarket rack systems, display cases and walk-ins with remote condensing systems.
- All medium/large refrigeration systems have liquid receivers which act as a storage buffer to maintain system performance and efficiency during the expected 10-30% annual leak rates.
- These systems would experience poor temperature control prior to any detectable electricity efficiency impacts, and maintaining temperature is the primary importance for facility operators.
- Experts interviewed suggested that a theoretical 0-5% electricity savings may occur for individual sites, but there is no documented evidence that leak detection would predictably achieve electricity and demand savings.
- **It is not likely Michigan utilities could offer EWR incentives for refrigerant leakage management due to the limited opportunity for electricity savings and a low utility cost effectiveness test.**
- It is unlikely that a leakage management program would offer the necessary predictable energy savings to operate a utility energy efficiency program.

Alternative Refrigerants for New vs. Retrofit Systems

- C&I buildings with packaged or field-assembled refrigeration systems have several options to reduce the GWP of their facilities.
 - **New facilities:** purchase new systems with lower GWP refrigerants, can design the facility around flammability, toxicity, and pressure risks.
 - **Existing facilities:**
 1. Retrofit existing systems with select lower GWP refrigerants to achieve >50% GWP reduction (\$100k-\$200k for supermarket)
 2. Full system replacement at end-of-life, can select a wider range of lower GWP refrigerants and system architectures (>\$1M for supermarket)
- The refrigerant opportunities for new and retrofit applications will depend upon the system type, design, operating temperatures, and other characteristics.
 - R448A/R449A is a retrofit solution for larger R22, R404, and R507 systems; 513A is a retrofit solution for larger R134a systems
 - The cost/complexity for refrigerant retrofits is prohibitive for small-to-medium packaged refrigeration systems, and almost never done today.
 - New small self-contained systems can use hydrocarbons (R-290 propane) but existing systems can not be retrofit for hydrocarbons.
 - Similarly, new rack and remote condensing systems can use CO2, but existing systems cannot be retrofit for CO2. (included in appendix)

Common Refrigerants for Commercial Refrigeration Systems and Low GWP Alternatives

	GWP Level*	Refrigerant	GWP (AR4)	Safety Class	Retrofit
Retrofit	High	R-507A	3,985	A1	No
		R-404A	3,922	A1	No
	Moderate	R-134a	1,430	A1	Yes
	Moderate	R-448/R449	1,400	A1	Yes
	Low	R-513A	630	A1	Yes
	Low	R-450A	601	A1	Yes
New Systems Only	Very Low	R-454A	237	A2L	No
	Very Low	R-471A	142	A1	No**
	Ultra Low	R-600a (isobutane)	3	A3	No
	Ultra Low	R-290 (propane)	3	A3	No
	Ultra Low	R-744 (CO2)	1	A1	No
	Ultra Low	R-717 (ammonia)	0	B2L	No

*Guidehouse's rough categorization, there is not industry consensus on these classifications

**R-471A is not marketed for retrofits today, but could be in the future since it is an A1 refrigerant

Key Findings and Conclusions: Alternative Refrigerant Retrofits

- A refrigerant retrofit project would involve switching out a high GWP refrigerant in an existing refrigeration system with a new, lower GWP refrigerant (e.g., replacing R-404A with R-448A or R-449A).
- Alternative refrigerant retrofits are only applicable for larger commercial refrigeration systems, and a retrofit project requires the installation of new system components and commissioning.
- **A “drop-in” refrigerant retrofit could provide between 0-10% energy savings when paired with full system commissioning** (e.g., replacing components, updating controls, optimizing performance).
- Most customers today consider this type of project for the GHG emissions reduction as the primary benefit, with energy efficiency being the secondary benefit.
- Alternative refrigerant retrofit projects would expect a lengthy 10-to-30-year payback period to the customers under today’s refrigerant prices.
- DTE Electric would only be able to provide incentives based on the electricity savings. Interested C&I customers could apply for a rebate through the conventional C&I custom incentive program.
- **DTE will launch a small pilot program to help grocery stores and other commercial customers switch to lower GHG refrigerants.**

Commercial & Industrial Refrigeration Pilot – Next Steps

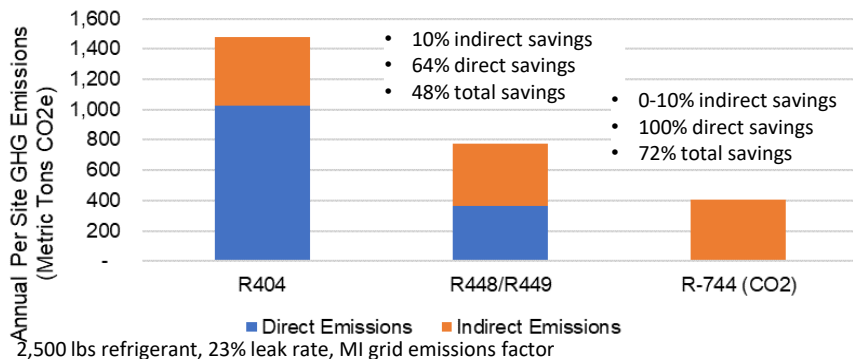
- Phase 1: - **complete**
 - DTE to conduct a Market and Feasibility Study for Commercial Refrigeration Pilots with two key Topics:
 - Topic 1: A drop-in refrigerant replacement program for various commercial refrigeration applications.
 - Topic 2: A “find and fix” refrigerant leakage reduction program focused on small grocery and convenience stores
- Phase 2: - **in progress**
 - Pilot start date – March 15,2023
 - Final report and pilot completion date – March 2024

Appendix

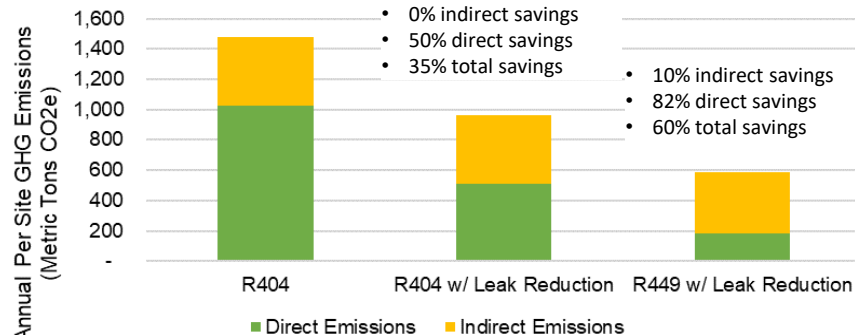
Indirect and Direct Emissions Benefits from Refrigerant-Related Measures

- Commercial and industrial customers are interested in alternative refrigerants and improved leakage management to reduce GHG emissions, and energy, refrigerant, and maintenance costs.
- In particular, large supermarket chains or corporations with GHG emissions targets have interest in reducing their direct and indirect emissions from the refrigeration systems. Federal and state regulations also target direct emissions.
 - Direct emissions are associated with refrigerant leakage during annual operation, servicing, and end-of-life.
 - Indirect emissions are associated with the system's electricity consumption and related power plant emissions.
- For baseline R-404a systems, annual GHG emissions are split 70% for direct emissions and 30% for indirect emissions.
- Facilities could achieve approximately 35-70% GHG emissions savings by adopting alternative refrigerants for new or existing systems and incorporating leakage management best practices.

Direct vs. Indirect Emissions for Alternative Refrigerants (Large Supermarket Systems)



Direct vs. Indirect Emissions for Leakage Reduction (Large Supermarket Systems)



Common Commercial Refrigeration Equipment Categories

High GWP (>1,500); Moderate GWP (<1,500); Low GWP (<700); Very-low GWP (<300), Ultra-low GWP (<10)

★ Key Opportunity for Pilots

Supermarket Rack Systems ★

Today: R-404A, R-507A, R-22, R-134a

Alternatives: R-448/R-449, R-744, R-717/R-744, distributed

R-290, R-454C, R-471A and other Very-low GWP blends

Leak Rate: High, 15-30%

Charge Size: Large/Very Large

Design: Field Assembly



Self-Contained Display Cases

Today: R-134a, R-404A

Alternatives: R-290, R-600a, R-516A, R-454C, R-455A and other Very-low GWP blends

Leak Rate: Low, < 5%

Charge Size: Low

Design: Factory Assembly



Display Cases and Walk-ins w/ Remote Condensing ★

Today: R-404A, R-507A, R-22, R-134a

Alternatives: R-448/R-449, R-744, R-454A, R-471A, and other Very-low GWP blends

Leak Rate: Moderate, 15%

Charge Size: Medium

Design: Field Assembly



Industrial Process Refrigeration / Cold Storage ★

Today: R-717, R-22, R-404A, R-507A, other high GWP options

Alternatives: R-448/R-449, R-717, R-744, R-471A, R-454C

Leak Rate: 20%, lower for ammonia systems

Charge Size: Large

Design: Field Assembly



Common Commercial Refrigeration Equipment Categories

High GWP (>1,500); Moderate GWP (<1,500); Low GWP (<700); Very-low GWP (<300), Ultra-low GWP (<10)

Refrigerated Food Processing and Dispensing Equipment

Today: R-134a, R-404A

Alternatives: R-290, R-600

Leak Rate: Low, < 1%

Charge Size: Large/Very Large

Design: Factory Assembly



Refrigerated Vending Machines

Today: R-134a, R-404A

Alternatives: R-290, R-744

Leak Rate: Low, < 1%

Charge Size: < 2 lbs

Design: Factory Assembly



Automatic Commercial Ice Makers

Today: R-410A, R-404A

Alternatives: R-290, R-717, R-744, R-448A/R-449A, R-513

Leak Rate: Low (<1%) for most

Charge Size: Low-to-moderate, 1-50 lbs

Design: Factory Assembly (most)



Ice Rinks (often chillers)

Today: R-717, R-404A, R-507A, R-434A, other high GWP options

Alternatives: R-448/R-449, R-717, R-744, R-471A

Leak Rate: High, 10-20%

Charge Size: Large

Design: Field Assembly

