The Hidden E-Strategy: Managing Refrigerants for Efficiency and the Economy

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ABSTRACT

Organizations are becoming more aware of the benefits of understanding the refrigerants used in their buildings and their impacts on operations and finances. Refrigerants are present in nearly every building. They can be found in air-conditioning systems, refrigeration equipment, water coolers, ice makers, dehumidifiers, heat pumps, fleet vehicles, and more. Refrigerant leakage reduces equipment efficiency and raises health and safety concerns, including exposure to chemicals, asphyxiation hazards, and flammability risks. In addition, replacing refrigerants can be expensive. Refrigerants are ubiquitous in buildings but are rarely tracked, despite evidence that refrigerant tracking and management can help businesses save money and protect assets. Developing and implementing a refrigerant management plan can help organizations track refrigerants and manage leaks to minimize cost and risk.

To improve the use and management of refrigerants, we brought together commercial building owners to discuss their knowledge about and management needs for refrigerants and learned that they have varying levels of refrigerant management experiences. To understand these experiences and develop pathways to better manage refrigerants, members of the Managing Refrigerants working group of the Better Buildings & Better Plants Initiative examined ways to reduce leaks, make operations more efficient, and build financial justifications for implementing those solutions. Best practices, such as methods to track refrigerant use and integrate refrigerants into operational plans, culminated in a refrigerant management action plan. This paper summarizes key feedback from the working group and outlines strategies for managing refrigerants in building portfolios of all sizes.

Introduction

The U.S. Department of Energy's (DOE's) Better Buildings & Better Plants (BBBP) Initiative is a voluntary, private-public partnership program designed to drive leadership in energy innovation by accelerating investment and sharing successful best practices in the public and private sectors. DOE works with industry leaders to help identify and understand barriers as they work toward operational performance goals. These leaders have the opportunity to voluntarily strive towards DOE set goals to become Partners in the Initiative.

To ensure progress towards these goals, DOE uses several strategies, including producing webinars, publishing case studies on the DOE BBBP website, hosting a peer-to-peer exchange and annual conference, and supporting working groups. In these working groups, participants engage and learn from one another, gather information about barriers, and provide useful feedback on resource development for broader dissemination. A working group will focus on one specific area that participants are interested in and work to address the problem over the course of several months (Goetsch et al. 2024; Torcellini et al. 2022). A typical outcome can be a guidance document that captures the discussion and recommendations of the working group

(Goetsch et al. 2024; Torcellini et al. 2022). The Managing Refrigerants working group of BBBP Initiative explored solutions for reducing leaks and improving operational efficiency and evaluated the economic benefits of implementing these solutions.

The objectives of the working group were to:

- Support working group participants in preventing and minimizing problems that occur when refrigerants leak or are not managed properly.
- Identify and learn about the technical and nontechnical challenges involved in managing refrigerants.
- Provide and possibly develop information resources to overcome these challenges.
- Share successes and lessons learned.

The working group included portfolio owners operating multiple buildings, hosting about twenty partners across six sectors including:

- Food service and grocery
- Commercial real estate
- Multifamily housing
- State and local government
- Higher education
- Healthcare.

The topics of discussion included:

- An overview of working group objectives and a review of how refrigerants are used.
- Measuring and managing refrigerant emissions.
- Natural refrigerants (e.g., non-synthetic refrigerants like carbon dioxide).
- Reducing leaks and maintaining refrigerant charge.
- Creating an action plan and wrap-up.

The discussion captured in this document is based on this discussion with the participants and has not been expanded upon or embellished with additional information.

Refrigerant Background

The first working session reviewed background information on refrigerants and common terminology as well as where refrigerants can be found in buildings. As shown in Figure 1, refrigerants play a major role in heating, ventilating, and air-conditioning (HVAC) and refrigeration systems. Some equipment is pre-charged with refrigerant when it is purchased. In other cases, such as variable refrigerant flow HVAC systems or large systems in general, refrigerant may be added on-site during installation.

Refrigerants are primarily used to move heat from one location to another, and their properties vary depending on application. For example, some refrigerants are more toxic or

flammable than others, some have been phased out of use or are not commonly adopted across different equipment types, and some can only operate at specific temperatures.

ASHRAE Standard 34 categorizes refrigerants by their safety risks. A letter indicates toxicity (A for low toxicity, B for high toxicity) and a number indicates flammability (1 indicates no flame propagation, 2L indicates low flammability, 2 indicates flammability, and 3 indicates high flammability) (ASHRAE 2019).

Some refrigerants are only used in certain types of equipment. For example, R-32 (A2L) and R-434a (A1) are often used in building applications such as window air conditioners and rooftop units, R-134A (A1) is often used in automotive air conditioning, and R-744 (carbon dioxide [CO_2], A1) is used primarily in larger systems like supermarket refrigeration systems.

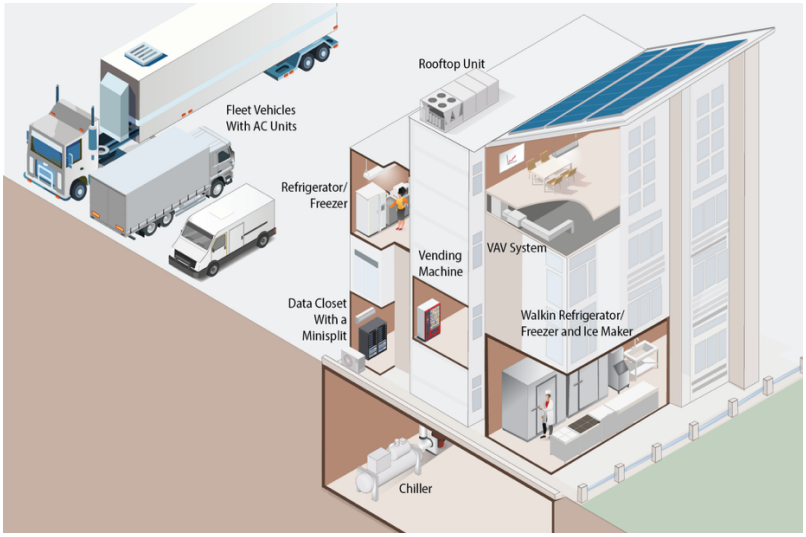

Figure 1. Refrigerants can be found in HVAC systems; refrigerators; freezers, including walk-ins and ice machines; fleet vehicles, if included in the portfolio; and cooling devices such as water fountains, cooled vending machines, etc. *Source:* Marjorie Schott, National Laboratory of the Rockies

Partners in the first working group session discussed where they use refrigerants; when, why, and how they manage refrigerants; and whether they currently track or manage refrigerants. Managing refrigerants can refer to handling, storing, and disposing of refrigerants in refrigeration systems to prevent leakage. They also discussed where they currently have refrigerants and whether they have concerns about those refrigerants and their management.

Partners who currently manage refrigerants discussed what resources they use and what resources they might still need. For example, partners would like to see case studies for CO_2 refrigerant use, independent guidance on CO_2 refrigerant system installations, estimates of equipment leaks, simple checklists for staff, and best practices for refrigerant management plans.

Information Collection

Existing Refrigerant Resources

In subsequent working group sessions, partners reviewed and discussed existing refrigerant resources including example refrigerant management plans (OGS 2026; CARB

2026). Partners also discussed their experiences and lessons learned in refrigerant inventory and management.

They cited resources including research and development literature and information provided by national labs, DOE, and manufacturers. They also recommended creating an accurate, up-to-date inventory of pieces of equipment, or assets, as a first step. Where applicable, they suggested communicating with the local authority having jurisdiction to learn about regulations and then talking with equipment manufacturers to gain an understanding of the costs and benefits of different strategies. In addition, some partners pointed out that it is important to leverage assets' equipment life cycles and known capital investments when considering replacements. For example, as equipment approaches its typical end of life, it may be beneficial to replace the entire system with one that includes leak detection and to choose refrigerants aligned with the goals of the owner (e.g., to achieve operational cost savings). Finally, it's important to focus on heating or cooling system efficiencies, refrigerant volumes, and leakage points. It may also be worth considering whether reclaiming, reusing, or retrofitting existing assets is possible and if it can be cost-effective.

One partner noted that, from their perspective, the best refrigerant is the one that stays in the equipment. This insight highlights the need for refrigerant monitoring, leak detection, and proper safety procedures; equipment needs to be maintained and regularly checked to minimize leaks. The configuration of the refrigeration equipment can also impact the amount of refrigerant needed and the potential for leaks. Some system types are less prone to leakage.

Gaps in Information Collection

During working group sessions, we asked participants a variety of questions about their experiences managing refrigerants. Using online whiteboards, we read participants' written responses and listened to their active discussions. Examples of discussion questions included:

- Questions about partners' refrigerant management experience:
    - How is servicing of your HVAC/refrigeration systems tracked/managed?
    - What are the barriers to inventorying and measuring refrigerants?
    - Do you have experience addressing refrigerant leaks? If so, please describe.
    - Do you have experience reducing refrigerant charge?
- Questions to elicit feedback about a proposed refrigerant strategy resource:
    - What resources do you still need in order to develop your refrigerant strategy?
    - Do the questions below capture key issues you want resources to address? What other questions should a resource help answer?
        - How do I explain the importance of low impact refrigerants?
        - What systems require refrigerants?
        - Where do leaks often occur?
        - What implications of upcoming refrigerant phasedown should I be aware of?
        - Where do I begin in making an inventory of refrigerants?
        - How can I determine what refrigerants are needed in my building?

        - What are the strategies and opportunities for reducing refrigerant leakage?

    - Which aspects of the following draft refrigerant management action plan sound most useful to you?

        - Importance of managing refrigerants
        - Common terminology (systems that require refrigerants, parts of refrigeration system, different types of refrigerants)
        - Impacts of refrigerants and systems
        - Phasedown implications
        - Making an inventory of refrigerants
        - Evaluation of system requirements
        - Strategies for reducing refrigerant leakage.

    - What is missing from the draft action plan?

Participant Responses

Refrigerant management experience. Some partners were unsure where to begin and end when inventorying refrigerants. Partners also had difficulty obtaining internal buy-in from vendors or investors. Typically, smaller equipment is not monitored as closely as larger refrigeration systems, and design parameters focus on system efficiency rather than the type of refrigerant. Therefore, it is important to discuss options with the manufacturer to ensure that the final choices meet expectations. Some partners also mentioned needing a clearer understanding of common terminology (for example, refrigerant charge).

Partners used different asset management systems to help them track inventory and service records. Partners reported that some of their property managers will share information, while others will not, and still others will not track refrigerants. Partners with larger sites often have work management tools that track refrigerants, with contractors or vendors often being responsible for data input. Purchasing records tracked through work order systems can also be used for tracking.

In terms of barriers to inventorying and measuring refrigerants, many partners have difficulty getting the correct data, and partners with many diverse facilities sometimes find it difficult to begin tracking refrigerants. Even with an established system, it is easier to get reliable data from larger facilities or equipment, and it can be especially difficult to get data for smaller systems or to know where to draw the line for assessing smaller equipment (e.g., all equipment, equipment with >50 pounds of refrigerant, >15 pounds, >1 pound?). It can also be difficult to get data from vendors about the quantity of refrigerants in equipment or the amount of refrigerant replaced. Furthermore, not all facility sites use maintenance tracking systems, making it challenging to track refrigerant levels of all the equipment in their facilities.

Few partners had experience in detecting and addressing refrigerant leaks. For those that did, it was more common to have leak detection systems in larger equipment. For mid-size equipment (packaged HVAC and walk-in freezers), quarterly or annual maintenance checks were sometimes reported as a monitoring method. For smaller equipment, refrigerant monitoring was not available. A leak might be detected if the system was not providing sufficient cooling, and leaks can also indicate that a piece of equipment is at the end of its life cycle. Based on

purchasing records, topping off refrigerant in systems did not appear to be a regular maintenance task. In addition, some partners mentioned that vendors were not always proactive in reporting leaks.

There were some examples of reducing refrigerant charge. One was an effort to right-size equipment during renovations in multifamily housing, but it was mostly based on improving heating and cooling efficiency. Other examples looked at using secondary loops to move cooling (such as chilled water or CO_2) and only having refrigerant in the refrigeration unit. Examples of this are using chillers with water loops where the refrigerant is contained only in the chiller.

Proposed Refrigerant Strategy Resource. Several partners liked the idea of tracking asset refrigerant usage in ENERGY STAR Portfolio Manager (EPA 2026). In addition, information about how the cost of refrigerants might change as they are phased out will be useful to help with financial planning. Some partners were also interested in tools for making financial comparisons and calculating the risk or cost of inaction (for example, deferred maintenance) so they could share the information with their leadership. Partners were interested in a resource that includes common terminology explanations and guidance on creating a refrigerant inventory. Partners also asked for additional information on phasedown implications and strategies for reducing leaks.

Solutions

To address partner feedback, national lab experts created a guide for developing a building-level action plan to manage refrigerants (Goetsch and Torcellini 2026). Partners reviewed the draft plan, and we included their feedback in subsequent edits.

The guide includes information on the importance of refrigerant inventories for various audiences. It also includes general refrigerant terminology, including safety classifications; common refrigerants found in HVAC equipment and their properties; and the reasons for tracking refrigerants.

In addition, it identifies the steps involved in completing an action plan for inventorying refrigerants. These include establishing the goals of the refrigerant management effort; documenting current methods, tools, processes, or reporting platforms; and explaining how data might be collected and stored and who should have access to that information. A series of questions and example answers guide users through the steps.

If the user does not yet have a systematic approach for collecting refrigerant use information, the guide includes an example table (Table 1) to complete a refrigeration equipment inventory. This table guides the user with column headers of important information to be collected for each equipment asset in the building that contains a refrigerant. A description of each column header appears below the table. Table 1 is a result of discussion with the working group and is a basic template for tracking refrigerant charge. Users may want to include other metrics that are related to maintenance but not directly associated with tracking refrigerant charge such as ambient temperatures and suction and discharge pressures.

Table 1. Gathering data on refrigerant use in building equipment assets using a refrigeration equipment inventory example

Asset description	Asset location	Asset tag number	Asset category	Date equipment put into service	Refrigerant used	Manufacturer-specified charge?	Automatic leak detection?

Asset description: Description of the assets that contain refrigerant. For example, "Chiller 1" or "Refrigerator West Break Room"
Asset location: Room number or other identifier used to locate the asset.
Asset tag number: In many organizations, assets are tagged as part of the inventory to track the asset and its value. Asset tags are also used to determine when an asset will be retired or replaced. Often assets are tagged with barcodes and can be scanned during a routine building sweep to verify that the asset still exists or to attach service requests and repair reports. Each asset has a unique identification number, which can be translated to a barcode for easy scanning during inventory sweeps or maintenance logging.
Asset category: Example categories include chiller, variable air volume system, rooftop unit, mini-split, refrigerator, freezer, ice maker, and fleet vehicle air-conditioning unit.
Date equipment put into service: This is usually the equipment installation date. For smaller pieces of equipment such as refrigerators, however, it could be the purchase date. Although not a critical data point, it is often useful to know the age of a piece of equipment, which could help determine how the equipment is serviced. For example, do you want to replace or repair a piece of equipment with an expected lifetime of 20 years that is 30 years old?
Refrigerant used: If available, a description or chemical name of the refrigerant in the asset.
Manufacturer-specified charge: The manufacturer's recommended refrigerant charge for the asset or system, often measured in pounds or kilograms. The manufacturer specifies the charge in the refrigerant circuit and if the service technician notices that the charge is low, refrigerant is added until the refrigerant charge is at the manufacturer recommended level.
Automatic leak detection: Larger systems contain sensors to monitor for the presence of refrigerant in the air and provide alerts when a leak is detected. (Small appliances such as refrigerators, dehumidifiers, window air-conditioners, ice makers, freezers, and water coolers are factory-sealed systems. These systems often indicate the refrigerant type and sometimes indicate the amount of refrigerant charge in the system. These systems are often not repairable and cannot be recharged.)

After the refrigeration equipment inventory, the guide walks the user through developing a refrigerant charge maintenance inventory. Table 2 shows the functions that a facility employee

or contractor would need to check to maintain refrigerant-containing equipment.

Table 2. Field record of refrigerant maintenance

Asset tag number	Refrigerant used (from Table 1)	Refrigerant charge check date	Amount of refrigerant added (e.g., pounds)	Other maintenance tasks completed	Maintenance staff member or contractor	Location of repair/leak (e.g., circuit, component)

After the refrigeration charge maintenance inventory, the guide ends with questions structured to help facilitate results by using the management plan. These questions help drive actions towards the goals set and help create a plan to meet those goals. Important considerations include verifying that equipment is working well (e.g., comparing evaporator outlet temperature to ambient temperature), identifying equipment or systems that are always problematic or more likely to leak, and noting equipment that is nearing its end of life and suggesting available options.

Conclusion

The working group model in the Better Buildings & Better Plants Initiative is a productive tool to help understand industry concerns about barriers and transform those concerns into useful resources to help lower those barriers. The Managing Refrigerants working group was an example of such a successful collaboration. Through web-based meetings on specific topics, self-selected industry partners asked questions, provided experience, and offered feedback on topics that national lab researchers could then use to develop a resource to help industry leaders make more informed refrigerant management decisions (Goetsch and Torcellini 2026). These efforts through the working group support improving efficiency and reducing costs for commercial building owners and facility managers through active refrigerant management and leak detection and prevention.

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