



Photo by Dennis Schroeder, NREL

The Hydrofluorocarbon Phasedown and Commercial Space Conditioning: A Guide to the Transition

Introduction

You may be aware of the hydrofluorocarbon (HFC) phasedown, but the details and its impact on your operations may still be unclear. Or perhaps this is the first you're hearing about the phasedown. In either case, this guide provides information to aid conversations with facility managers and engineers and provides an explanation of how the phasedown affects equipment in commercial buildings. It also includes actions you and your organization can take now to properly plan and prepare.

Background

The American Innovation and Manufacturing (AIM) Act was enacted in December 2020 and gives the Environmental Protection Agency (EPA) authorization to manage HFCs,¹ a group of industrial chemicals primarily used as refrigerants

in a range of commercial building applications, like space conditioning, water heating, and refrigeration. In addition, several states^{2,3} have adopted refrigerant regulations of their own. While slightly different than those of the EPA, state regulations have similar goals and phasedown timelines.

HFCs released into the atmosphere through leaks or maintenance procedures pose a significant global warming impact that can be many times greater than carbon dioxide on a per volume basis.⁴ The AIM Act outlines a 15-year phasedown schedule to reduce the production and consumption of HFCs by 85% on a weighted global warming potential (GWP) basis. To achieve this, the EPA developed baseline levels and established the methodology to meet the AIM Act phasedown schedule.¹ **Figure 1** illustrates the HFC production and consumption phasedown schedule as outlined in the AIM Act.

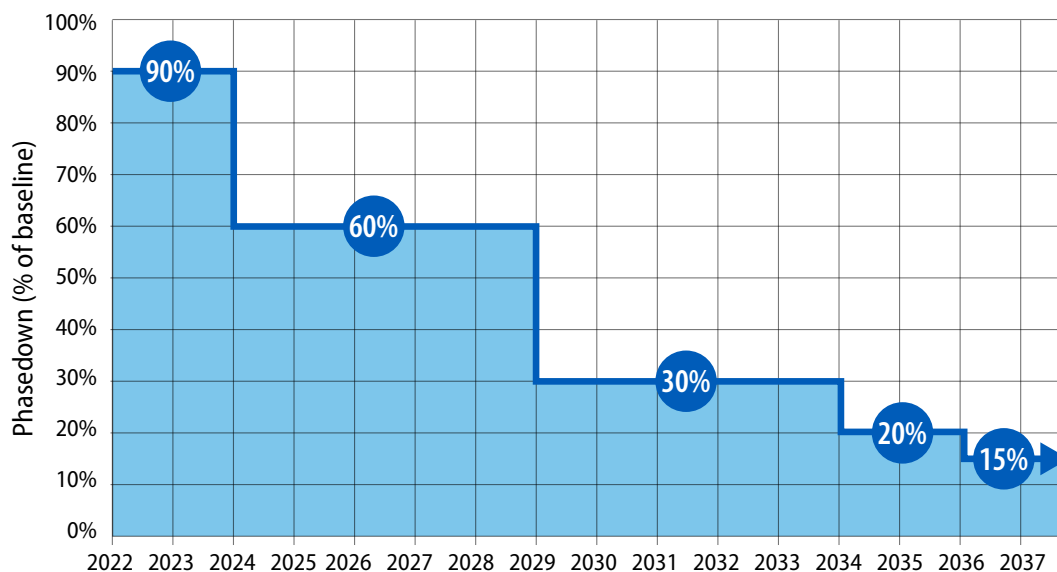


Figure 1. Phasedown Schedule¹

1 U.S. Environmental Protection Agency. 2022. "Final Rule – Phasedown of Hydrofluorocarbons: Establishing the Allowance Allocation and Trading Program Under the AIM Act." Accessed November 23, 2022. <https://www.epa.gov/climate-hfcs-reduction/final-rule-phasedown-hydrofluorocarbons-establishing-allowance-allocation>

2 U.S. Climate Alliance. 2022. "United States Climate Alliance." Accessed November 23, 2022. <http://www.usclimatealliance.org/>

3 Natural Resources Defense Council. 2022. "Phasing Down HFCs." Accessed November 23, 2022. <https://www.nrdc.org/issues/phase-down-hfcs>

4 U.S. Environmental Protection Agency. 2022. "Reducing Hydrofluorocarbon (HFC) Use and Emissions in the Federal Sector through SNAP." Accessed November 23, 2022. <https://www.epa.gov/snap/reducing-hydrofluorocarbon-hfc-use-and-emissions-federal-sector-through-snap>



Purpose

This guide is an introduction to the phasedown and is designed to help building owners and facility managers prepare for upcoming phasedown transitions and shift away from high GWP refrigerants. While existing equipment and their refrigerants do not need to be replaced, all new equipment must be compliant with the phasedown requirements.

Refrigerants

Refrigerants are used by many types of commercial building equipment, including HVAC equipment, refrigerators, standalone refrigerator cases, and more. This guide primarily discusses commercial HVAC equipment, but the phasedown will impact all equipment utilizing refrigerants. Refrigerants vary in chemical makeup, toxicity, and flammability, and these classifications are governed by ASHRAE Standard 34.⁵ **Figure 2** shows safety group classifications.

The safety group classification of a specific refrigerant leads to design and management considerations to account for any hazardous properties. Group A1 is ideal from a safety perspective, but all refrigerants have characteristics that require thoughtful management. ASHRAE Standard 15⁵ provides the requirements for safe design, construction, installation, and operation of many of the various types of HVAC and refrigeration systems.⁵

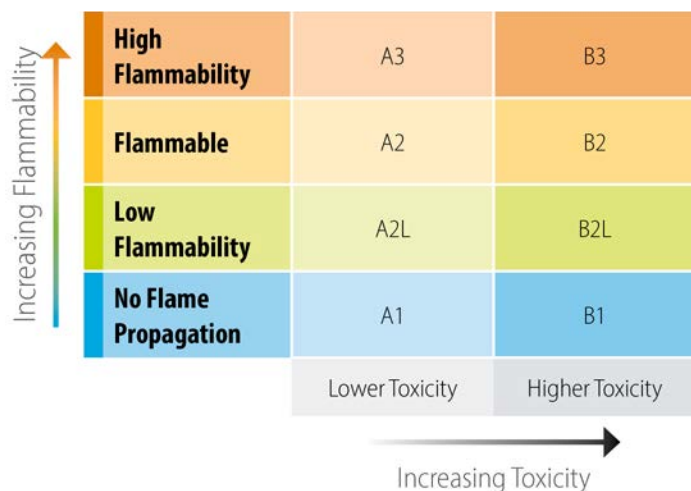


Figure 2. Refrigerant Safety Group Classification (The letter refers to the toxicity, and the number refers to the flammability.)

In addition to the potential hazards from toxicity and flammability, refrigerants may leak into the atmosphere leading to significant global warming effects, which is the impetus for the HFC phasedown. The metric associated with global warming is known as GWP and is a measure of

how much infrared energy the emissions of 1 ton of a gas will absorb over a given period relative to the emissions of 1 ton of carbon dioxide.⁶ A higher GWP value translates into a larger potential to warm the Earth. **Table 1** summarizes common refrigerants used in commercial building HVAC systems, along with the safety group classification and the GWP value.

Table 1. Summary of Common HVAC System Refrigerants^a

HVAC System Type	Refrigerant	Safety Group Classification	100-Year GWP
Packaged HVAC	R-22	A1	1,960
	R-410A	A1	2,256
Chillers (in addition to R-22)	R-134a	A1	1,530

a. All values from AR6: Smith, C., Z.R.J. Nicholls, K. Armour, W. Collins, P. Forster, M. Meinshausen, M.D. Palmer, and M. Watanabe, 2021: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity Supplementary Material. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Available from <https://www.ipcc.ch/>.

It is important to note that R-22, also known by the brand name Freon, is a hydrochlorofluorocarbon (HCFC) and not an HFC. As of 2020, R-22 was banned from production and importation in the U.S. by the EPA. This action was part of the phaseout of ozone depleting substances originally outlined by the Montreal Protocol.⁷ The phasedown discussed in this guide is seeking to reduce GWP by 85%, but not completely phase it out.

Medium and Low-GWP Refrigerant Options

Medium- and low-GWP refrigerants currently exist for various applications. However, different manufacturers may be using different refrigerants, so it is important to understand the options and key characteristics when selecting equipment. **Table 2** provides information on currently available refrigerant alternatives for common low, medium, and high-pressure applications.

There are natural refrigerants with very low GWP values that can also be used in certain applications; however, many of them have other challenges such as high flammability or high toxicity (see **Table 3**). Hydrocarbons (propane and isobutane) work very well for refrigerators, coolers, and small air conditioning systems, but there is a charge limit of 150 grams for most applications due to the high flammability safety rating. Ammonia is a very effective refrigerant and is

5 ASHRAE. 2022. "ASHRAE Refrigeration Resources." Accessed November 23, 2022. <https://www.ashrae.org/technical-resources/bookstore/ashrae-refrigeration-resources>

6 Clark, Ezra and OzonAction. "Global Warming Potential (GWP) of Refrigerants: Why are Particular Values Used?" United Nations Environment Programme. https://wedocs.unep.org/bitstream/handle/20.500.11822/28246/7789GWPRef_EN.pdf?sequence=2&isAllowed=y

7 United Nations Environment Programme. 2022. "About Montreal Protocol." Accessed November 23, 2022. <https://www.unep.org/ozonaction/who-we-are/about-montreal-protocol>

often used for very large refrigeration systems in warehouses and meat packing plants; however, it has a high toxicity safety rating and must be carefully handled. Carbon dioxide is gaining some favor for super market refrigeration systems and air-to-water heat pumps; however, there are challenges with the corresponding high-pressure systems needed and performance in hot climates.

Table 2. Refrigerant Alternatives

Low-Pressure Alternatives to Replace R-123 and R-245fa (for centrifugal chillers, heat pump systems, binary generators, urethane foaming processes, among others ^a)				
Alternative Refrigerants	GWP	Safety Group Classifications	Relative Capacity (R-123 = 1)	Relative Capacity (R-245fa = 1)
R-1233zd(E) ^b	1	A1	1.4	0.9
R-514A ^b	2	B1	0.95	0.6
Medium-Pressure Alternatives to Replace R-134a (for water cooled chillers, air conditioning systems, heat pumps, medium temperature commercial and industrial refrigeration systems, and others ^c)				
Alternative Refrigerants	GWP	Safety Group Classifications	Relative Capacity (R-134a = 1)	
R-513A ^d	673	A1	1.04	
R-515B ^d	321	A1	1	
R-1234ze(E) ^d	1.4	A2L	0.75	
High-Pressure Alternatives to Replace R-410A (for rooftop units and other packaged HVAC systems)				
Alternative Refrigerants	GWP	Safety Group Classifications	Relative Capacity (R-410A = 1)	
R-32 ^d	771	A2L	1.1	
R-454B ^d	531	A2L	0.97	

- a. North American Sustainable Refrigeration Council. 2022. "NASRC Aggregated Incentives Program (AIP) Pilot." Accessed November 23, 2022. <https://nasrc.org/aggregated-incentives-program>
- b. AGC Chemicals. "Amolea 1224yd." Tokyo, Japan: AGC Chemicals. <https://www.agc-chemicals.com/file.jsp?id=30728>
- c. American Innovation and Manufacturing Act, 2022, sec. 103(h)(5). [https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title42-section7675\(a\)&num=0&edition=prelim](https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title42-section7675(a)&num=0&edition=prelim)
- d. AR6: Smith, C., Z.R.J. Nicholls, K. Armour, W. Collins, P. Forster, M. Meinshausen, M.D. Palmer, and M. Watanabe, 2021: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity Supplementary Material. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Available from <https://www.ipcc.ch/>.

Table 3. Natural Refrigerants

Natural Refrigerants	GWP ^a	Safety Group Classifications	Uses
R290 – Propane	0.020	A3	Refrigerators, freezers, ice machines, vending machines, small air conditioning systems
R600a – Isobutane	0.006	A3	Refrigerators, freezers, ice machines, vending machines
R717 – Ammonia	0	B2L	Very large refrigeration systems
R744 – Carbon dioxide	1	A1	Supermarket refrigeration system, heat pump water heaters

- a. All values from AR6: Smith, C., Z.R.J. Nicholls, K. Armour, W. Collins, P. Forster, M. Meinshausen, M.D. Palmer, and M. Watanabe, 2021: The Earth's Energy Budget, Climate Feedbacks, and Climate Sensitivity Supplementary Material. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Available from <https://www.ipcc.ch/>.

Commercial Buildings Impacts

The HFC phasedown affects commercial buildings both directly and indirectly:

- Companies that manufacture and distribute HFCs are the most impacted and will need to alter entire product lines to be compliant with the phasedown.
- Those utilizing HFCs, such as HVAC and refrigeration equipment manufacturers, will need to adjust product lines and equipment to accommodate new refrigerants and refrigerant blends that are allowed to be manufactured and distributed.
- Building owners and companies replacing existing equipment or planning new construction will need to consider new equipment offerings and potential impacts on performance targets⁸ as well as new record keeping and reporting requirements.
- HVAC technicians and engineers face a large impact as well and should understand the classification and safety requirements of new refrigerants, which will require new training, certifications, refrigerant management, and record keeping.^{9,10}

These impacts will apply to equipment such as direct expansion (DX) air conditioning systems, heat pumps, chillers, and refrigeration equipment. Building owners and facility managers should also keep in mind that many available low-GWP refrigerants, and even natural refrigerants, may have safety group classifications other than A1. This may

8 Office of Air and Radiation. 2021. "Final Rule – Phasedown of Hydrofluorocarbons" Establishing the Allowance Allocation and Trading Program Under the American Innovation and Manufacturing (AIM) Act." Washington, D.C.: U.S. Environmental Protection Agency. <https://www.epa.gov/system/files/documents/2021-09/hfc-allocation-rule-nprm-fact-sheet-finalrule.pdf>

9 EPA Section 608 certification. <https://www.epa.gov/section608/section-608-technician-certification>

10 McMorrow, Shane. 2022. "Refrigerant Recovery: Why and How." HVACR Career Connect New York. Accessed November 23, 2022. <https://hvacrcareerconnectny.com/refrigerant-recovery-why-and-how/>

require modifying existing compliance steps for maintaining a safe environment in addition to replacing the equipment.

Incentives and Assistance

Some states, like Delaware¹¹ and California,¹² have incentive programs to financially aid in the transition. Where available, it's ideal to take advantage of assistance and incentive programs; do not wait until an equipment failure requires a refrigerant or equipment changeout. Business sector organizations are also coordinating assistance to aid their constituents in the transition;⁸ inquire with the partner and support organizations you work with to learn more about their programs. Additionally, Section 103(h)(5) of the AIM Act establishes a 3-year grant program for small businesses through 2023.¹¹ Pursue assistance from these programs if you qualify and stay up to date on program updates.

Cost Considerations

As the industry begins the HFC phasedown, especially as targets become more aggressive starting in 2024, supply of HFC refrigerants will decrease, which may cause prices to increase. It is beneficial to reclaim and recycle refrigerants from retiring equipment and use it to maintain equipment with years of operation left.⁷

When purchasing new equipment with low-GWP or natural refrigerants, keep in mind that additional safety measures to accommodate increased toxicity and flammability properties may require additional capital investment beyond the cost of the equipment replacement. Ensure you comply with all local codes around the safety of these systems.

Connecting with Installers and Contractors

The phasedown may be new to your installer or contractor. Education is important for all parties so the most appropriate decisions are made. There are many online resources that can help installers, technicians, and contractors understand the phasedown and prepare for associated impacts.¹³

Keep in mind that Section 608 of the Clean Air Act specifies refrigerant recovery equipment requirements,¹⁴ and you should ensure that this process is well monitored and documented by HVAC technicians to avoid inadvertently releasing HFC vapor into the atmosphere. It is explicitly prohibited to intentionally release (or vent) refrigerants, and there are specific EPA certifications for technicians who

perform any disposal of refrigerants in refrigeration and HVAC equipment.²¹

Conclusion

The HFC phasedown will impact your business operations, but with education and preparation you can effectively transition your portfolio to feature low-GWP refrigerants and compliant equipment. Explore assistance and additional education as the phasedown progresses to remain informed of your options and requirements.

What to Do Now

Although existing equipment does not need to be replaced as part of the phasedown, you can be proactive about your equipment and maintenance:

- ✓ First, understand federal, state, and local requirements and make plans for future phasedown steps.
- ✓ Ensure proper maintenance of existing equipment to reduce leaks and maintain efficiency.¹⁵
- ✓ Building owners and facility managers should create an inventory of existing refrigerants and equipment life expectancies, and develop a proactive repair and replacement plan that moves toward low-GWP compliant solutions.
- ✓ When considering the refrigerant options available as the phasedown progresses, find a balance between a lower GWP refrigerant, high efficiency, and low lifecycle costs.⁴ There are also low-GWP options on the market now, and the non-flammable options are the easiest to adopt.⁴
- ✓ It is not required to replace refrigerants in existing equipment, however, if you decide to replace refrigerants in existing equipment with a lower GWP refrigerant, it is important to ensure all equipment and parts are compatible.
- ✓ When looking forward, consider if you'd like to adopt a single refrigerant, or if it's acceptable to have multiple refrigerants across the buildings in your portfolio.
- ✓ It will be beneficial to keep an eye on the market for refrigerants and the price changes that may result from the phasedown as this could affect maintenance budget planning.
- ✓ When constructing a new building or replacing existing equipment, adopt the newest and most compliant equipment to minimize compliance issues moving forward.

11 Delaware.gov. 2022. "Cool Switch Low Impact Refrigerant Program." Accessed November 23, 2022. <https://dnrec.alpha.delaware.gov/climate-coastal-energy/efficiency/cool-switch/>

12 California Air Resources Board. 2022. "Low-GWP Incentives." Accessed November 23, 2022. <https://ww2.arb.ca.gov/resources/documents/low-gwp-incentives>

13 Building Commissioning Association. 2021. "Next-Generation MEP: 10 Ways to Prepare for the Low-GWP Refrigerant Economy." Accessed November 23, 2022. <https://www.bcx.org/blog/next-generation-mep.html>

14 Environmental Protection Agency. 2011. "Construction and Demolition." Washington, D.C.: U.S. Environmental Protection Agency. https://www.epa.gov/sites/default/files/documents/ConstrAnd-Demo_EquipDisposal.pdf

15 Better Buildings U.S. Department of Energy. 2022. "Hydrofluorocarbon: What to Expect Over the Next 15 Years." Accessed November 23, 2022. <https://betterbuildingsolutioncenter.energy.gov/webinars/hydrofluorocarbon-phase-down-what-expect-over-next-15-years>