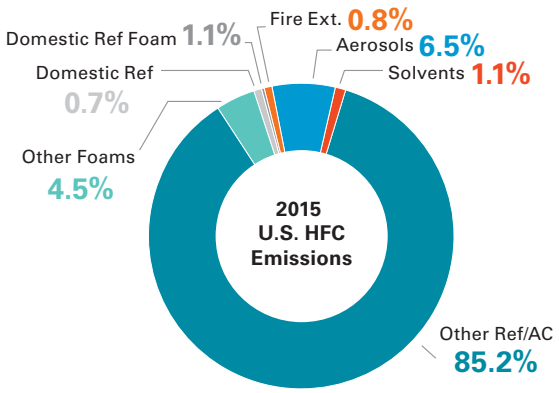
TRANSITIONING TO LOW-GWP ALTERNATIVES
in Domestic Refrigeration

Background

This fact sheet provides current information on low global warming potential (GWP)[1] alternative refrigerants to high-GWP hydrofluorocarbons (HFCs) for use in domestic refrigeration equipment. HFCs are powerful greenhouse gases (GHGs) with GWPs hundreds to thousands of times more potent per pound than carbon dioxide (CO_2); however, more low-GWP alternatives are becoming available.

In 2015, an estimated 164 million domestic refrigerators and freezers were in operation in the United States. Approximately 10.7 million new units are produced and sold annually. Domestic refrigerators and freezers typically contain 0.1–0.6 lbs. of refrigerant and approximately 2 lbs. of blowing agent for the insulating foam. Charge sizes in the United States have decreased over the years.

Domestic refrigeration accounted for roughly 2% of U.S. HFC emissions in 2015. These emissions can easily be avoided through the purchase of refrigerators that contain low-GWP refrigerants and foams, and by the proper disposal of old units.



U.S. HFC Emissions: 169 MMT CO_2Eq.
U.S. HFC Emissions in Domestic Refrigerators: 1.2 MMT CO_2Eq.
U.S. HFC Emissions in Domestic Refrigerator Foam: 1.8 MMT CO_2Eq.

Low-GWP Alternatives and Market Trends

In the past, domestic refrigerators and freezers contained CFC-12 refrigerant and CFC-11 foam-blowing agent. These substances destroy the stratospheric ozone layer, which shields the Earth from the sun's harmful ultraviolet radiation, and contribute to climate change. Domestic refrigerator and freezer manufacturers transitioned to non-ozone depleting HFC-134a refrigerant and to HCFC-141b foam-blowing agent in the mid-1990s, the latter of which has more recently been replaced by HFC-134a, HFC-245fa, and hydrocarbons (HCs). In 2015, an estimated 40% of units sold in the United States contained HC-blown foam. HC refrigerants began entering the U.S. market in 2010, and have been growing in market share since.

EPA's Significant New Alternatives Policy (SNAP) Program ensures the smooth transition to alternatives that pose lower overall risk to human health and the environment. Under SNAP, EPA has listed several low-GWP alternative refrigerants as acceptable for use in domestic refrigerators and freezers, including isobutane (R-600a), propane (R-290), R-441A (a blend of ethane, propane, butane, and isobutane), R-450A (an HFO/HFC blend), and R-513A (an HFO/HFC blend), and foam blowing agents, including HCs, oxygenated hydrocarbons (HCOs) such as methyl formate and methylal, HFO-1336mzz(Z), Solstice™-1233zd(E), and HFO-1234ze. None of these alternatives deplete the ozone layer and all have significantly lower impacts to the climate system than CFCs, HCFCs, and HFCs.

As shown in Table 1 on the next page, a SNAP rulemaking published in July 2015 lists several foam blowing agents as unacceptable in rigid polyurethane appliance foam (used in domestic refrigerators and freezers) starting in 2022. Another SNAP rulemaking published in December 2016 lists 28 refrigerants as unacceptable in new household refrigerators and freezers starting in 2021.

[1] GWP is a measure of a substance's climate warming impact compared to CO_2.

Table 1. Changes in SNAP Listing Status for Substitutes in Domestic Refrigeration

End-Use	Substitutes	Final Rule Change of Status Date*
Household Refrigerators and Freezers (New)	FOR12A, FOR12B, HFC-134a, KDD6, R-125/290/134a/600a (55.0/1.0/42.5/1.5), R-404A, R-407C, R-407F, R-410A, R-410B, R-417A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-426A, R-428A, R-434A, R-437A, R-438A, R-507A, RS-24 (2002 formulation), RS-44 (2003 formulation), SP34E, and THR-03	January 1, 2021
Rigid Polyurethane Appliance Foam	HFC-134a, HFC-245fa, HFC-365mfc and blends thereof; Formacel TI, and Formacel Z-6	January 1, 2020

*Please refer to the SNAP website for more detailed information about unacceptable foam blowing agents and refrigerants and more details on when the changes in listing status will become effective.

Refrigerants:

HCs

- Includes isobutane (R-600a), propane (R-290), and R-441A
- In 2010, GE introduced the Monogram® refrigerator line containing isobutane refrigerant and HC refrigerants have continued to grow in market share since then; HCs already dominate the market in Europe, Japan, and China
- HC refrigerants improve energy efficiency of refrigerators over HFC-134a, resulting in cost savings for consumers

HFOs and HFO/HFC Blends

- Includes R-450A (a blend of HFO-1234ze(E) and HFC-134a) and R-513A (a blend of HFO-1234yf and HFC-134a)
- HFO-1234yf, used in motor vehicle air conditioners, could also become viable for refrigerators/freezers

Foam Blowing Agents:

Cyclopentane Blends

- Cyclopentane, cyclopentane/isopentane, and cyclopentane/isobutane blends are the most globally used blowing agents in domestic refrigeration
- In 2011, GE became the first U.S. appliance manufacturer to adopt cyclopentane blowing agent in its top-freezer refrigerators produced out of its Decatur, AL plant

Low-GWP Fluorinated Compounds

- Includes Solstice™ 1233zd(E), HFO-1234ze, and HFO-1336mzz(Z) (Formacel® 1100)
- Whirlpool Corporation has implemented the use of Solstice™-1233zd(E) as the blowing agent in its U.S.-made refrigerators and freezers

HCOs (Methylal, Methyl Formate)

- Typically intended for use as a co-blowing agent with an HC or HFC blowing agent

Table 2. GWPs of Refrigerants and Blowing Agents for Domestic Refrigeration

Chemical	GWP*
Refrigerant	
CFC-12	10,900
HFC-134a	1,430
R-513A	630
R-450A	601
R-441A	<5
HFO-1234yf	4
Propane (R-290)	3.3
Isobutane (R-600a)	3
Blowing Agent	
CFC-11	4,750
HCFC-142b	2,310
HCFC-22	1,810
HFC-134a	1,430
HFC-245fa	1,030
HFC-365mfc	794
HCFC-141b	725
Cyclopentane	<10
Isopentane	<10
HFO-1336mzz(Z)	9
Solstice™ 1233zd(E)	4.7-7
HFO-1234ze	6
Methyl Formate	<5
Methylal	<3

Note: Chemicals in gray shading are no longer used in new equipment because of their ozone depletion potential.

* GWP values are from the Intergovernmental Panel on Climate Change Fourth Assessment Report: Climate Change 2007.

U.S. Efforts to Reduce GHG Emissions through Proper Appliance Disposal

U.S. EPA's Responsible Appliance Disposal (RAD) program is a partnership that protects the ozone layer and cuts emissions of GHGs by working with utilities, retailers, manufacturers, states, affiliates, and others to dispose of refrigerated appliances using the best environmental practices available and going beyond what is required by federal law. RAD partners work with recyclers to ensure the proper recovery of both refrigerant and foam from appliances reaching end-of-life.

Since the Program's inception in October 2006, RAD partners have collected and processed nearly 6.5 million domestic refrigerators and freezers, as well as over 55,600 air conditioning units and dehumidifiers, from which they recovered nearly 1.1 million lbs. of HFC refrigerants and foams. Collectively, RAD partners have achieved emission reductions of nearly 14.3 million MT CO_2 Eq., which is equal to taking over 3 million passenger cars off the road for one year. Of this, 61% can be attributed to recovering refrigerants, 31% to recovering foam-blowing agents, and 8% to recycling durable materials.

To learn more about the RAD program and how you can become a partner, visit http://www.epa.gov/rad.

Significant New Alternatives Policy (SNAP) Program Facts

- Program authorized under Clean Air Act Title VI
- Evaluates substitutes and lists as acceptable those that reduce overall risk to human health and environment; lists acceptable with use conditions if needed to ensure safe use; or lists as unacceptable.
- Industrial sectors include: Refrigeration and Air Conditioning, Foam Blowing, Solvent Cleaning, Fire Suppression, Aerosols, Sterilants, Adhesives, Coatings and Inks, and Tobacco Expansion.
- Since it was established in 1994, SNAP has reviewed over 400 substitutes.
- SNAP considers:
  - Ozone Depleting Potential (ODP)
  - Global Warming Potential (GWP)
  - Flammability
  - Toxicity
  - Occupational and Consumer Health/Safety
  - Local Air Quality
  - Ecosystem Effects

Future Outlook

Together, the suite of known alternative chemicals, new technologies, as well as better process and handling practices, can significantly reduce HFC use in both the near and long term. Although much work remains to fully adopt these chemicals, technologies, and practices, and some unknowns still remain, the equipment manufacturers and chemical producers for the domestic refrigeration and freezer industry are working on developing new alternatives. Over the next few years, EPA is expecting to issue listings potentially adding several low-GWP options for new domestic refrigerators and freezers.

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EPA 430F14021 • www.epa.gov/snap • December 2016