2015 Annual Report

The U.S. Environmental Protection Agency's (EPA's) Responsible Appliance Disposal (RAD) program is a partnership launched in October 2006 to protect the ozone layer, cut greenhouse gas (GHG) emissions, and benefit communities. The RAD program recognizes partners that commit to collecting and disposing of old refrigerated appliances using the best environmental practices available and going beyond what is required by federal law.

The RAD program invites utilities, retailers, manufacturers, state and local governments, universities, and other qualifying organizations to become partners. The RAD program also invites states to become RAD affiliates to promote the program to potential partners and increase environmental benefits for their states and communities.

What Is RAD?

In 2015, an estimated 12 million refrigerators and freezers, 9 million window air conditioning units, and 2 million dehumidifiers were disposed of in the United States. These units contain ozone-depleting substances (ODS), hydrofluorocarbons (HFCs), hazardous substances, and recyclable materials.

EPA requires recovery of ODS and HFC refrigerant prior to appliance dismantling or disposal. Federal law also requires proper management and storage of universal waste (e.g., mercury), used oil, and polychlorinated biphenyls (PCBs) prior to appliance disposal or recycling. However, federal regulations do not require the recovery of appliance foam, which contains substances that are potent GHGs and that may, depending on the vintage of the unit, deplete the ozone layer. Further, up to 25% of disposed refrigerators/freezers are resold onto the secondary market;[1] the continued use of these older, less efficient models demands more energy from the nation's grid.

Partners in EPA's RAD program commit to collecting used refrigerated appliances and implementing best practices for the disposal of these units that go beyond federal laws. This means:

- ✓ Recovering appliance foam
- ✓ Complying with laws on the recovery of refrigerant, used oil, mercury, and PCBs
- ✓ Promoting recycling of all durable goods
- ✓ Promoting the permanent retirement of old, inefficient appliances to save energy

As a result of their commitments, partners prevent emissions of ODS and GHGs, save landfill space through recycling, reduce energy consumption, and prevent the release of hazardous substances. RAD partners achieve these benefits with the help of an appliance recycler who uses best environmental practices (see figure).

[1]Based on studies published by Cadmus Group, Innovologie, NMR Group, and the U.S. Department of Energy.

This annual report presents RAD partners' environmental achievements for 2015

CONSUMERS

Refrigerators
Freezers
Window Air Conditioners
Dehumidifiers

RAD PARTNERS

Retailers
Utilities
Local Governments
Manufacturers
Other

APPLIANCE RECYCLERS

Foam → Reclamation / Destruction
Refrigerant → Reclamation / Destruction
Metals, Plastics, Glass → Recycling
PCBs, Used Oil, Mercury → Proper Disposal

BENEFITS

Prevents Emissions of ODS and GHGs
Prevents Release of Hazardous Substances
Saves Landfill Space through Recycling
Reduces Energy Consumption

RAD Partners and Affiliates

In 2015, RAD partners achieved nationwide coverage servicing 50 states plus the District of Columbia and Puerto Rico. This included the addition of three new partners—one utility, one independent appliance retailer, and the Program's very first state partner. RAD's coverage is an impressive accomplishment, especially in light of the unexpected market changes in 2015—namely the depression of the scrap metals recycling market and the closure of one of the largest appliance recycling companies that supports RAD partners, JACO Environmental, Inc. Despite these changes, most RAD partners have found alternate means to continue recycling appliances the "RAD way."

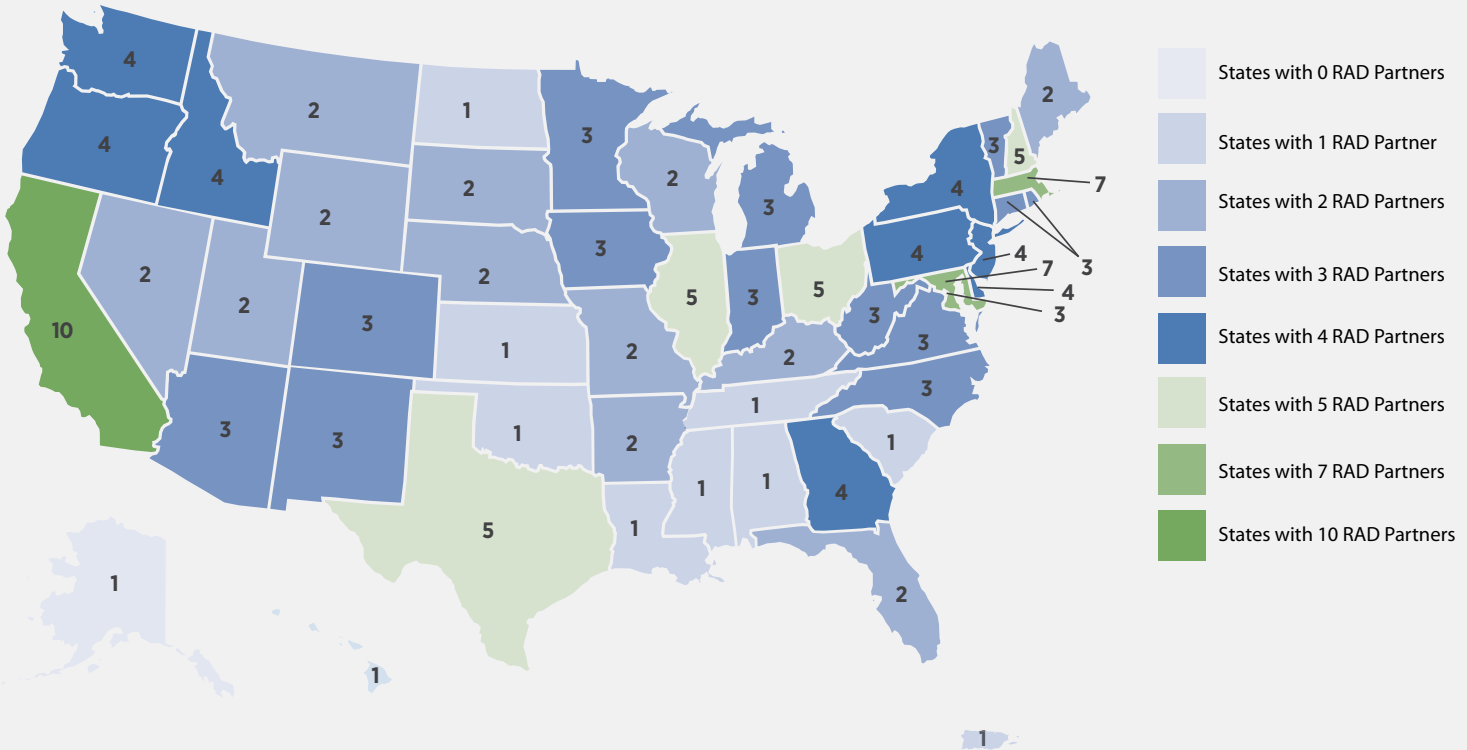
New RAD Partners in 2015

Liberty Utilities

SPICHERS
Appliances, Electronics, & Security
Family owned and operated since 1955

Delaware Health and Social Services

Map of RAD Partners and Affiliates



Utilities, Retailers, Manufacturers, and States

State Affiliates

Meet the Recyclers that Support RAD Partners

RAD partners work with recyclers to ensure the proper recovery of foam from end-of-life refrigerated appliances. While each recycler uses different methods for processing refrigerated appliances, all lead to significant ozone and climate benefits compared to business-as-usual disposal practices.

Founded in 1976, ARCA and ARCA Advanced Processing (ARCA-AP) have facilities in 15 states (CA, CO, GA, IL, KY, MA, MN, NM, NY, OH, OR, PA, TX, VA, WA). All ARCA facilities use manual and semi-automated foam processing methods, except for their Advanced Processing facility, which uses fully automated foam processing methods. To learn more, visit: www.ARCARecyclingInc.com.

Photo Credit: ARCA-AP

ARCA's UNTHA Recycling Technology (URT) system (pictured above) can process approximately one refrigerator per minute. The URT system has processed approximately 380,000 refrigerators since 2011.

Founded in 2012, Recleim has a fully automated white goods and air conditioning equipment advanced recycling plant in South Carolina, including the only closed-loop foam processing line in the United States. In addition, Recleim operates facilities in FL, IL, MD, NY, PA, RI, and VA that process non-refrigerant based appliances and act as hubs for the transportation of appliances containing refrigerant and foam insulation to the South Carolina facility. To learn more, visit: www.recleim.com.

Photo Credit: Recleim

Recleim's closed-loop Adelmann recycling system (pictured above) is the only one of its kind in North America. The Adelmann system is currently being used throughout Europe as the standard for appliance recycling and resource recovery.

RAD Results

In 2015, RAD partners collected and processed a total of 810,190 refrigerant-containing appliances, representing an estimated 4% of the total number disposed in the United States. This includes:

725,467 Refrigerators

3,250 Dehumidifiers

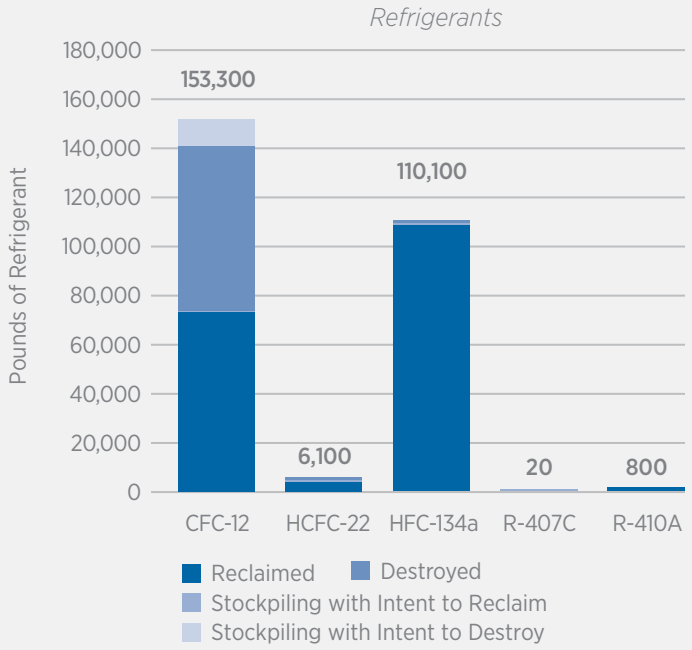
73,656 Stand-Alone Freezers

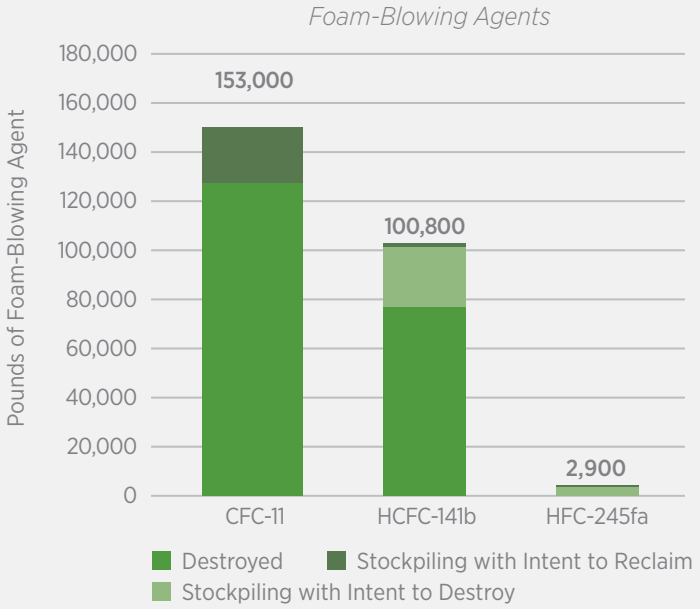
7,817 Air Conditioning Units

By disposing of these units using the best environmental practices, RAD partners have helped reduce emissions of ODS and GHGs by safely recovering significant amounts of chlorofluorocarbon (CFC), hydrochlorofluorocarbon (HCFC), and HFC refrigerants and foam-blowing agents, as shown in the sidebar graph.

Partners have also helped to reduce energy use and avoid the release of harmful substances to the environment. These environmental benefits are described in more detail on the following pages.

Refrigerants and Foam-Blowing Agents Reclaimed or Destroyed by RAD Partners in 2015





Stratospheric Ozone Benefits

Older refrigerated appliances that were manufactured with ODS refrigerants and foam-blowing agents are being retired and safely disposed by RAD partners. In 2015, RAD partners avoided the release of 143 ODP-weighted metric tons of ODS which otherwise would have contributed to stratospheric ozone depletion.

Ozone depletion causes increased amounts of UV radiation to reach the Earth's surface. Overexposure to UV radiation can cause a range of health effects, including skin cancer (melanoma and non-melanoma), premature aging of the skin and other skin problems, cataracts and other eye damage, and suppression of the immune system.

While only some refrigerants and foam-blowing agents deplete the ozone layer, all have high global warming potentials (see table below) which contribute to global climate change, as discussed further on the next page.

Characteristics of Gases Used as Refrigerants and Foam-Blowing Agents in Appliances Reaching End-of-Life

Compound	Ozone Depletion Potential (ODP)†	Global Warming Potential (GWP)*	Predominant Use in Appliances
CFC-11	1	4,750	Foam
CFC-12	1	10,900	Refrigerant
HCFC-22	0.055	1,810	Refrigerant
HCFC-141b	0.11	725	Foam
HFC-134a	0	1,430	Refrigerant
HFC-245fa	0	1,030	Foam

† ODPs are based on values provided in the Montreal Protocol.

*GWP calculations are based on the 100-year direct GWPs provided in the Intergovernmental Panel on Climate Change Fourth Assessment Report (2007), which are relative to CO_2.

Ozone Layer on the Mend

Actions taken under the *Montreal Protocol on Substances that Deplete the Ozone Layer* have led to substantial decreases in the abundance of ODS in the atmosphere. Although the "ozone hole"—an annual thinning of the ozone layer over the Antarctic—continues to occur each spring, a near complete recovery is expected to occur around mid-century.[1] In 2016, for the first time, researchers have found evidence that the ozone hole is shrinking. Using measurements from satellites, ground-based instruments, and ozone-measuring weather balloons, a research team showed that since 2000, the ozone hole shrunk by 4 million square kilometers—about half the area of the contiguous United States.[2,3]

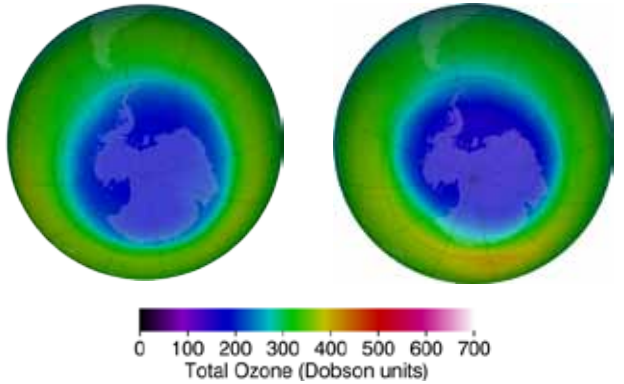


Image of the monthly-averaged total ozone over the Antarctic pole in September 1987 as the Montreal Protocol was being signed (left) and in September 2016 (right). The blue and purple colors represent areas with the least ozone, and the yellow and red colors represent areas with the most ozone.

Photo Credit: National Aeronautics and Space Administration (NASA) Ozone Hole Watch, September 2016.

[1] World Meteorological Organization (2014). Assessment for Decision-Makers: Scientific Assessment of Ozone Depletion: 2014. 10 September 2014.

[2] *Science* 1 Jul 2016 Vol. 353, Issue 6294, pp. 16-17.

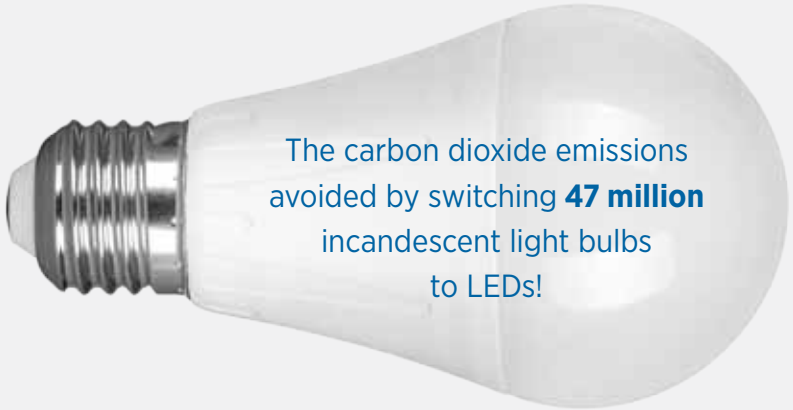
[3] *Science* 15 Jul 2016 Vol. 353, Issue 6296, pp. 269-274.

Climate Benefits

During 2015, RAD partners achieved a reduction of 1.3 million metric tons of carbon dioxide equivalent ($MTCO_2eq$), which is equal to the annual carbon emissions from the electricity use of nearly 195,000 homes. Of this, 63% can be attributed to reclaiming or destroying refrigerants, 27% to reclaiming or destroying foam-blowing agents, and 10% to recycling durable materials (which avoids the need to produce virgin materials). Additional climate benefits are realized through energy savings, as detailed on the next page.

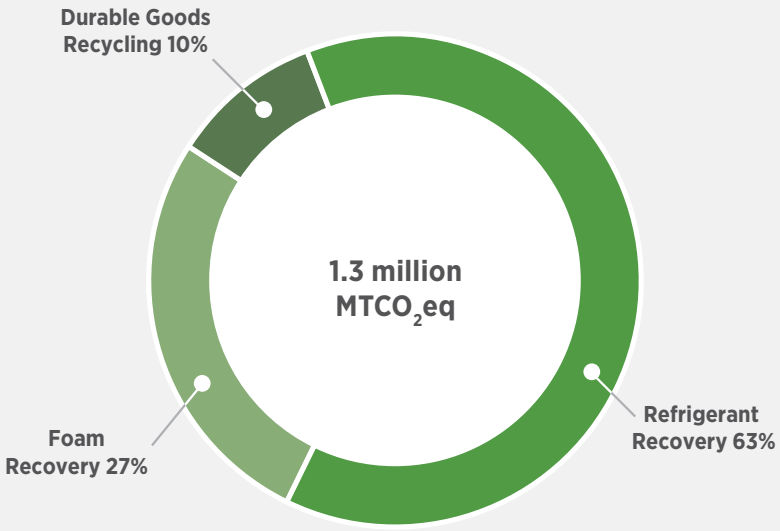
In addition to CFCs and HCFCs, RAD partners prevent the release of HFCs. Like CFCs and HCFCs, HFCs are potent GHGs commonly used in refrigerators and air conditioners. HFCs are rapidly increasing in the atmosphere mostly due to increased demand for refrigeration and air conditioning, particularly in developing countries, and because they are the primary substitute for ODS being phased out under the Clean Air Act and the *Montreal Protocol on Substances that Deplete the Ozone Layer*. Recovering HFCs from appliances at end-of-life can lead to significant climate benefits. During 2015, RAD partners recovered 114,000 lbs. of HFCs, avoiding GHG emissions equivalent to nearly 11,000 homes' electricity use for one year.

In 2015, RAD partners
achieved climate benefits equivalent to:



The carbon dioxide emissions avoided by switching **47 million** incandescent light bulbs to LEDs!

GHG Emissions Avoided through Proper Appliance Disposal by RAD Partners in 2015



Energy Savings

RAD's utility partners are committed to ensuring that old, inefficient appliances being disposed of by one household do not get reused by other households. This reduces indirect GHG emissions associated with the generation of electricity.

In total, RAD utility partners reduced energy use by 2.2 billion kWh in 2015. These energy savings translate to climate benefits of 1.5 million $MTCO_2eq$ and are estimated to have saved consumers $307 million.

RAD utility partners achieve these savings by offering cash for old appliances and/or rebates on the purchase of new ENERGY STAR units, as part of demand-side management programs aimed at reducing electricity use through energy efficiency and conservation. In recent years, many of these utilities have joined forces with RAD retailer partners that allow them to broaden their reach into consumer appliance disposal channels. Together, these partners have made impressive strides in collecting more units and saving an increasing amount of energy.

Replacing a 15-year-old refrigerator with one that is ENERGY STAR certified will save a household more than 400 kWh/year – or about $50/year.*

*Actual energy and cost savings will vary by equipment model and region. These estimates are conservative. EPA: ENERGY STAR 2015 Databook.

Flip-Your-Fridge Campaign

ENERGY STAR's Flip-Your-Fridge campaign encourages consumers to recycle old, inefficient refrigerators and replace them with new ENERGY STAR certified models. Through this program, consumers save energy, help protect the climate, and benefit from rebates available for purchases and recycling.

If all the old refrigerators in the United States were replaced with new ENERGY STAR certified models, it would save more than a billion dollars in annual energy costs. The energy savings would power 800,000 homes and prevent 12 billion pounds of GHG emissions in just one year. For more information, visit: https://www.energystar.gov/products/appliances/nows_time_flip_your_fridge_and_save.

Environmental Benefits for Communities

In 2015, RAD partners further protected the environment by keeping recyclable materials out of landfills and ensuring the proper handling of hazardous waste, as shown below.

Materials prevented from going to a landfill:

- **112 million lbs.** of ferrous metals (e.g., steel)
- **5 million lbs.** of non-ferrous metals (e.g., copper)
- **17 million lbs.** of plastic
- **3 million lbs.** of glass

Toxic or hazardous materials properly handled:

- **58,600** gallons of used oil
- **31,400** PCB-containing capacitors
- **19,900** mercury-containing components

Environmental & Human Health Benefits from Avoided Releases

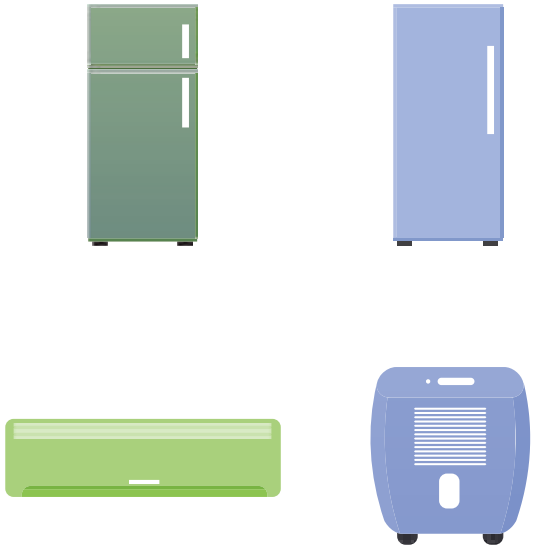
If released into the environment, **used oil** can leak into groundwater and major waterways and pollute drinking water sources. In addition to used oil, appliances may contain toxic chemicals and heavy metals— namely **PCBs** from capacitors and **mercury** from thermostatic switches. PCBs are regulated by EPA as toxic substances; they may cause cancer and liver damage and can have negative impacts on the neurological development of children, the human reproductive system, the immune system, and the endocrine system. Mercury is toxic and causes a variety of adverse health effects, including tremors, headaches, respiratory failure, reproductive and developmental abnormalities, and potentially, cancers.

Benefits Achieved Since Program Inception

Since its inception in October 2006, the RAD program has achieved significant benefits for our environment and community at large. By working together to reduce emissions of ODS and GHGs, save energy, increase the recycling of durable goods, and ensure the proper handling of hazardous substances, RAD partners have achieved the following cumulative impacts over the years:

6.5 million

refrigerated appliances recycled the "RAD way"



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- **1.1 billion** pounds of material diverted from landfills
- **1,645 tons** of ODS emissions avoided
- **30.2 million** $MTCO_2eq$ of GHG emissions avoided, equivalent to the annual emissions of **6.4 million** passenger cars
- **628,000** gallons of used oil and **395,000** hazardous components properly handled
- **22.8 billion** kWh saved and **$2.8 billion** in consumer savings from removing old units from the grid

Addressing HFCs at Home and Abroad

To reduce emissions of HFCs, EPA approves more sustainable alternatives to ODS and restricts certain uses of the most harmful HFCs. The table on the right provides information on recent Significant New Alternatives Policy (SNAP) actions that impact new household refrigerators. For additional information on EPA's SNAP program and actions that impact refrigerated appliances, visit https://www.epa.gov/snap.

The U.S. government is also addressing HFCs through public procurement of goods and services. In May 2016, the Department of Defense (DoD), General Services Administration (GSA), and National Aeronautics and Space Administration (NASA) published a final rule to amend the Federal Acquisition Regulation (FAR) to procure, when feasible, alternatives to high GWP HFCs. The final rule also encourages improved refrigerant management and requires contractors to keep track of and report on the amounts of HFCs added or removed during routine maintenance, service, repair, and disposal of government equipment, appliances, and supplies containing 50 pounds or more of HFCs.

In addition, various executive actions and private sector commitments were announced by the White House in 2015, which are expected to reduce consumption of HFCs by more than 1 billion $MTCO_2eq$ through 2025. This is equivalent to removing 210 million passenger vehicles from the road for a year.

Recent SNAP Determinations that Impact New Household Refrigerators*

Compound(s)	SNAP Determination	Effective Date
Foam-Blowing Agents		
HFC-134a, HFC-245fa, HFC-365mfc and blends thereof	Unacceptable	1/1/2020
Formacel TI and Formacel Z-6	Unacceptable	1/1/2020
Methylal and HFO–1336mzz(Z)	Acceptable	10/21/2014
Solstice™ 1233zd(E)	Acceptable	8/10/2012
Refrigerants		
R-513A	Acceptable	7/16/2015
R-290 (propane)	Acceptable	5/11/2015
R-450A	Acceptable	10/21/2014
R-600a (isobutane)	Acceptable	2/21/2012
R-134a	Unacceptable	1/1/2021

*For a complete list of acceptable substitutes in household refrigerators and freezers, visit https://www.epa.gov/snap/acceptable-substitutes-household-refrigerators-and-freezers.

International Action on HFCs

On October 15, 2016, 197 countries adopted an amendment to phase down HFCs under the *Montreal Protocol* in Kigali, Rwanda, committing to cutting the production and consumption of HFCs by 80-85 percent over the next 30 years. The ambitious phase down schedule will avoid more than 80 billion $MTCO_2eq$ by 2050—avoiding up to 0.5° Celsius warming by the end of the century—while continuing to protect the ozone layer.

Featured RAD Partner Activities

In 2015, RAD partners launched innovative promotions and campaigns to collect refrigerated appliances and raise consumer awareness about safe appliance disposal.

Baltimore Gas & Electric (BGE): Appliance Turn-In Events

In 2015, BGE's Smart Energy Savers Program held three room air conditioner and dehumidifier turn-in events in partnership with local community organizations. Advertised through press releases, social media, event calendar listings, and outreach to local organizations, the events allowed customers to recycle up to two old, working room air conditioners or dehumidifiers and receive a $25 reward per unit. BGE collected over 350 units at these events! Moreover, the events were a great opportunity to speak with customers about environmentally friendly recycling, other ways to save energy and money, and the RAD program.

PacifiCorp: Refrigerator Recycling Campaign

Using cash incentives, PacifiCorp worked with retailers in 2015 through its "See ya later, refrigerator"© program to collect and permanently retire working, less efficient appliances, preventing their resale on the secondary market. Over 95% of unit components and materials were either recycled for beneficial uses or disposed of in an environmentally responsible way.

Delmarva Power, Pepco, and Southern Maryland Electric Cooperative (SMECO): New Target on Dehumidifiers

In 2015, Delmarva Power, Pepco, and SMECO added dehumidifiers to their appliance recycling programs for the first time. Customers who opted to recycle a dehumidifier with a refrigerator or freezer were eligible for an additional $25 incentive. To accommodate the influx of qualifying appliances, the utilities worked side by side with Sears—a RAD retail partner—to schedule appliance pick-up appointments from consumers' homes.

GE Appliances (GEA): RAD Recruiting and Promotion

In 2015, GEA referred a family-owned independent retailer, Spichers Appliances, to the RAD program. Spichers Appliances has three stores with locations in Maryland, Pennsylvania, and Virginia. GEA's recruiting efforts demonstrate their leadership and commitment to expanding RAD's reach. GEA also promoted RAD through press releases and press events for their customers, as well as marketing materials that communicate the benefits of RAD.

Partners Meet to Exchange Best Practices

In August 2015, RAD Partners met to exchange best practices for multifamily appliance recycling programs. Partners had the opportunity to learn from the experiences of two RAD utilities, Puget Sound Energy (PSE) and San Diego Gas & Electric (SDG&E), in regards to program design and benefits. PSE and SDG&E described key lessons learned for meeting participants, including building appropriate marketing strategies and leveraging partnerships for effective programs.

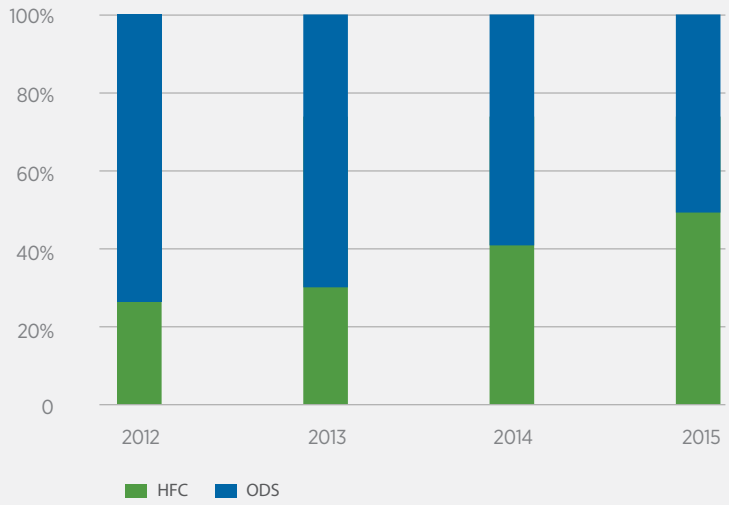
Meeting the Challenges of Today's World

As illustrated in the sidebar figures, RAD partners have historically processed appliances that primarily contain ODS refrigerants and foam-blowing agents. In recent years, RAD partners have begun to collect and process an increasing number of HFC-containing appliances. In fact, since 2012, the number of appliances containing HFC refrigerant has increased by nearly two times, while those containing HFC foam has increased by seven-fold. The number of HFC-containing appliances entering the disposal stream will continue to increase in the coming years, as the stock of older CFC and HCFC units decreases and more HFC units are retired. As global efforts increasingly focus on reducing emissions of HFCs and other greenhouse gases, **RAD partners can be seen as proud leaders in climate protection at home and abroad.**

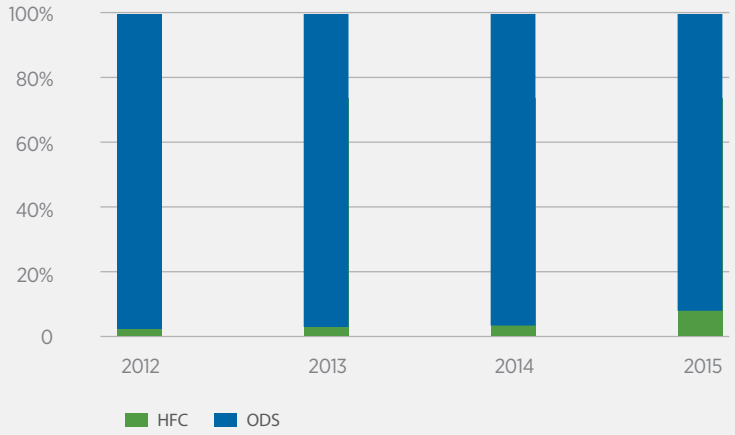
In 2016, if foam were properly recovered from all 12.3 million refrigerators disposed in the United States, 8.6 million $MTCO_2eq$ would be avoided; that's equal to the electricity use of nearly 1.3 million homes for one year!*

*U.S. EPA estimate, assuming 5% blowing agent recovery loss.

RAD Appliances Collected by Refrigerant Type



RAD Appliances Collected by Foam Type



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