How the New and Used Refrigerator Markets Are Intertwined

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ABSTRACT

This paper presents a detailed market analysis that describes both the new and used refrigerator markets in California. Because markets in other parts of the country are similar, our results have wide applicability. Understanding the new and used refrigerator markets is essential to understanding the need for refrigerator rebate programs, utility standalone refrigerator recycling programs, utility/retailer partnership recycling programs, and longer term refrigerator and freezer disposal issues.

Based on several years of research, and data from Association of Home Appliance Manufacturers (AHAM), surveys of utility customers disposing of refrigerators, and in-depth interviews with new and used refrigerator dealers, this paper describes and quantifies the flow of appliances from manufacturers, to retailers, to households, to secondary uses, and finally to disposal. The paper demonstrates that over the long term there is an underlying seven percent annual purchase rate for new refrigerators. Before 2006 between 14 and 16 percent of new refrigerator shipments went to new homes. With the economic downturn that began in 2006 as few as six percent of new refrigerators may be going to newly constructed homes. The balance is replacements for existing refrigerators.

The new refrigerator market is highly concentrated among 8-10 national retailers. More than 60 percent of refrigerators that are replaced are still working. Retailers only remove about a quarter of the refrigerators that are replaced annually and up to a quarter of these may return to the market. The used units that are not removed by retailers are sold, given to friends and neighbors, kept, find their way to a utility recycling program, or are taken to community waste facilities.

New and Used Refrigerator Markets in California

The new and used refrigerator markets in California are intertwined and their relationship is important to understanding the continuing demand for the appliance recycling programs.

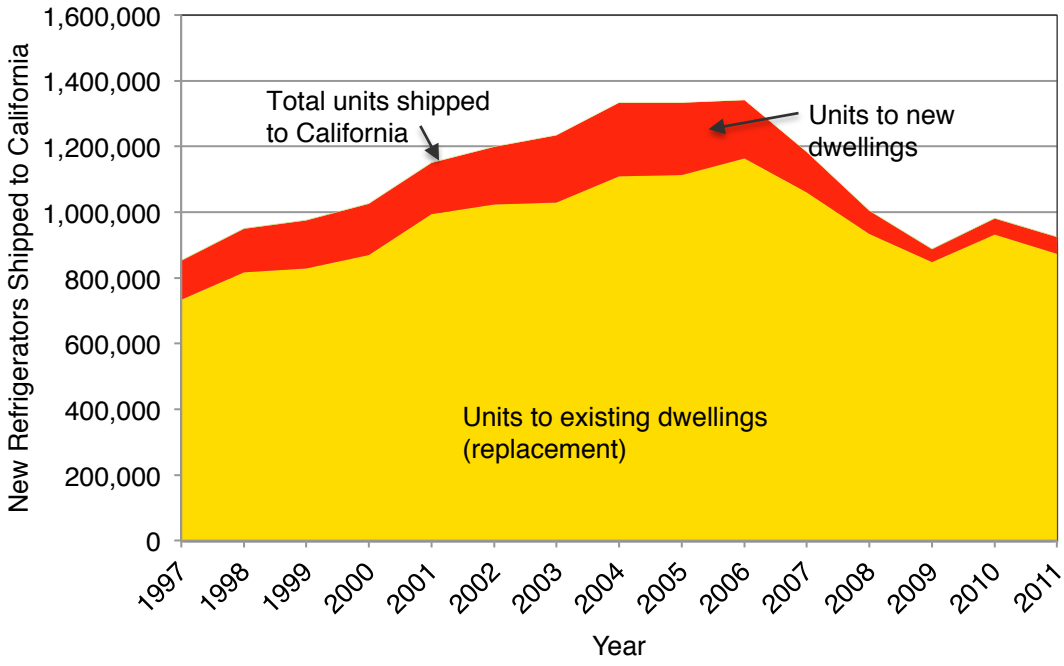
This paper addresses the following questions:

- How many new refrigerators enter the California market annually?
- How many of those refrigerators are a first use in new homes and how many are replacements for existing refrigerators?
- Who are the major retailers in the new appliance market?
- What paths do refrigerators and freezers follow in the disposal process?
- What do appliance retailers do with appliances that they remove?
- What are the economics of retailer appliance recycling?
- What happens to the materials recovered from refrigerators that are recycled?
- What percentage of the total market for refrigerators and freezers removed from households go to appliance retailers and what percentage follows other paths?
- What do these findings say about the need for utility recycling programs?

New Refrigerators Entering the California Market: Who Buys Them?

According to AHAM, the number of new refrigerators shipped to appliance distributors in California in the past 15 years averaged 1.09 million per year. The shipments peaked at about 1.34

million units between 2004 and 2006 and then declined rapidly to about 886,000 units in 2009.[1] This decline was heavily influenced by the housing downturn between 2006 and 2008. As shown in Figure 1 (the orange area), for the period from 1997 to 2011, between 39,000 and 224,000 units were placed in new dwellings annually. On average over the past 15 years, approximately 955,000 refrigerators were purchased annually for use in occupied households (yellow area).



Source: AHAM Shipments Data; Graphic Innovologie LLC 2012.

Figure 1 Estimated Total Shipments to California, Units Placed in New Dwellings, and Units Placed in Occupied Dwellings (Replacements)

[1] Almost all new homes have one new refrigerator. The numbers of these refrigerators being delivered to new homes annually can be estimated by combining new construction permit data with the relevant proportions of new homes with one or two new refrigerators. This number then can be deducted from the overall shipments to estimate the number of appliances being placed in existing homes. An analysis of the 2003 and 2010 California Residential Appliance Saturation Surveys (Table FTNT 1) revealed that the percent of new homes with more than one refrigerator increased from 24 to 29 percent between 2003 and 2010 and the percent of existing homes with a second refrigerator increased from 17 to 24 percent respectively.

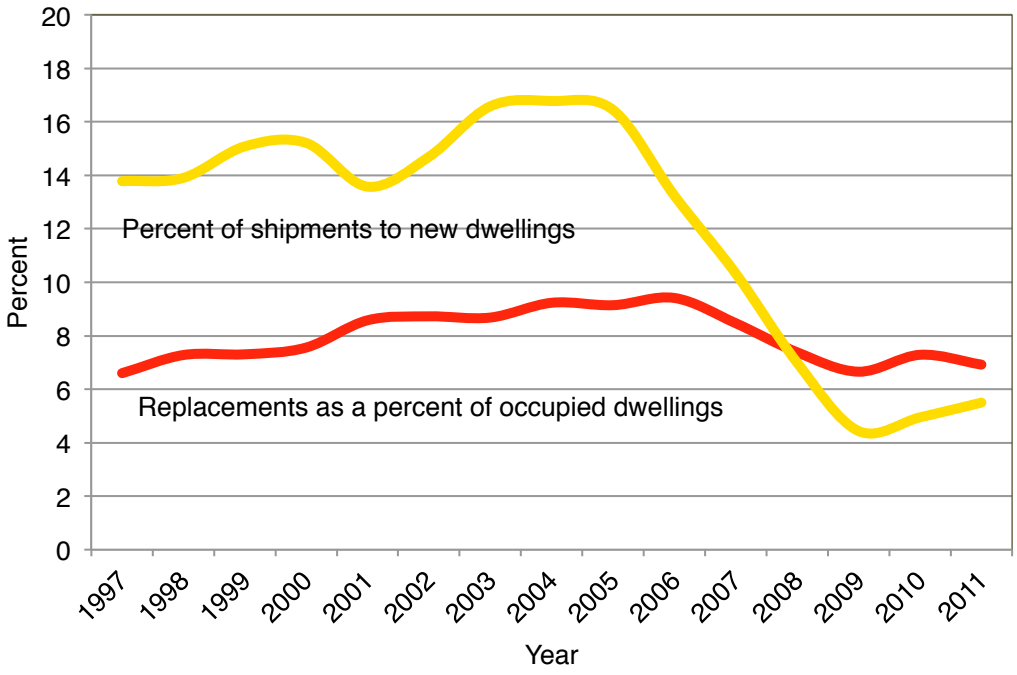
FTNT 1. Proportion of New and Existing Homes with a Second Refrigerator

	New Homes		**Old Homes**		**New Homes with Two New Units**
Second Refrigerators	Proportion	Annual Consumption (kWH)	Proportion	Annual Consumption kWh	
2003	0.24	999	0.17	1193	1.08
2010	0.29	1079	0.24	1227	1.05

This is the case despite the economic downturn that began in 2006. In both years, new homes had more second refrigerators than older homes. This may be because of the trend to larger new homes. Based on the RASS Surveys, it is estimated that about five and eight percent of new homes in 2003 and 2010 respectively had two new refrigerators, while the remainder of new homes with second refrigerators had a new and old unit.

Figure 2 shows the annual percentage of shipments of new units to new and occupied dwellings from 1997 to 2011. The percent of total shipments placed in new dwellings increased until 2006 and then diminished sharply thereafter ranging from a high of nearly 17 percent to a low of just over 4 percent. The highs occurred between 2004 and 2006 followed by a precipitous decline that reached its low in 2009. This decline coincided with the housing downturn in California.

Of more interest is that the annual purchase rate of refrigerators (replacement units) for occupied California households increased from slightly more than six to slightly more than nine percent between 1997 and 2006, and then declined to about six percent again. These data show that there is an underlying seven percent annual purchase rate of refrigerators for occupied dwellings that can increase to eight or nine percent in better economic times (e.g., between 2003 and 2006 when the refrigerator replacement purchase rate was above nine percent). Put differently, annually an average of seven percent of households dispose of a working or nonworking unit.



Source: AHAM Shipments Data; Graphic Innovologie LLC 2012.

Figure 2 Percent of Refrigerators Shipped and Placed in New Dwellings and Estimated Percentage of California Households that Purchased a New Refrigerator

The New Appliance Retail Market: Who Sells Them?

A number of market analyses confirm that the sales of all appliances nationally, including refrigerators, are highly concentrated among a few large retailers. For example, a U.S. Department of Energy (2009) study concluded that:

> Refrigerators are sold primarily through Sears, home improvement centers such as The Home Depot and Lowe's, mass merchants such as Costco and Sam's Club, and independent appliance retailers. The share of sales flowing through each of these channels has shifted over the last five years, with Sears and independent appliance dealers losing market share to home improvement retailers and mass merchants. In 2007,

> Sears and the home improvement sector each accounted for 33 percent of sales, independent retailers for 22 percent, and mass merchants for 11 percent. Four percent of sales went through other channels.

The home improvement sector's gain in market share is echoed in a more recent article in *This Week in Consumer Electronics* (TWICE) that referenced their list of the Top 100 major appliance dealers in the United States. TWICE reported:

> Clearly, the home-improvement sector made the most of last year's weak majap (major appliance) market. The nearly 4 percent gain by No. 2 retailer Lowe's helped offset single-digit declines at third-ranked The Home Depot and 16th place Menards, leaving sales within this strata flat at $8 billion, just behind the mass class. But with flat becoming the new measure of success in appliances, the results translated into a 3.8 percent gain in market share for the home-improvement gang, to 35.6 percent of Top 100 sales (Wolf).

According to TWICE, the ten largest major appliance dealers by sales account for 84 percent of the market and the market share gains of the Top 10 were at the expense of midsized dealers like Fry's. The Top 10 were: Sears, h.h.gregg, Lowe's, P.C. Richard & Son, The Home Depot, BrandsMart USA, Best Buy, Conn's, Wal Mart, and Costco. Some of these retailers, like h.h.gregg, do not have stores in California (Wolf).

Used Refrigerators and Freezers: Where They Go

If they do not remain in the household, used refrigerators and freezers typically follow one of four paths (Reed, *et. al.*, forthcoming). As shown in Figure 3, they are: sold or are given to another household; removed by a utility sponsored recycling program; removed by a retailer and then sold or recycled; or removed through a community waste program or another disposal mechanism such as firms that will pickup a unit for free or for a fee. The volume in this latter path is negligible and will be ignored in this discussion. There are other paths of disposal such as illegal dumping but the numbers are small and there is no data. Recycling programs also experience the theft of units placed outside for removal.

Path One: Sold or Given to Another Household

When a householder transfers the unit to another holder, it is usually given away or sold. If given away it is typically to someone that is known to the householder. If sold they are sometimes sold to someone known to the householder or to a party located through an advertisement on Craigslist, PennySaver, or some similar community bulletin board.

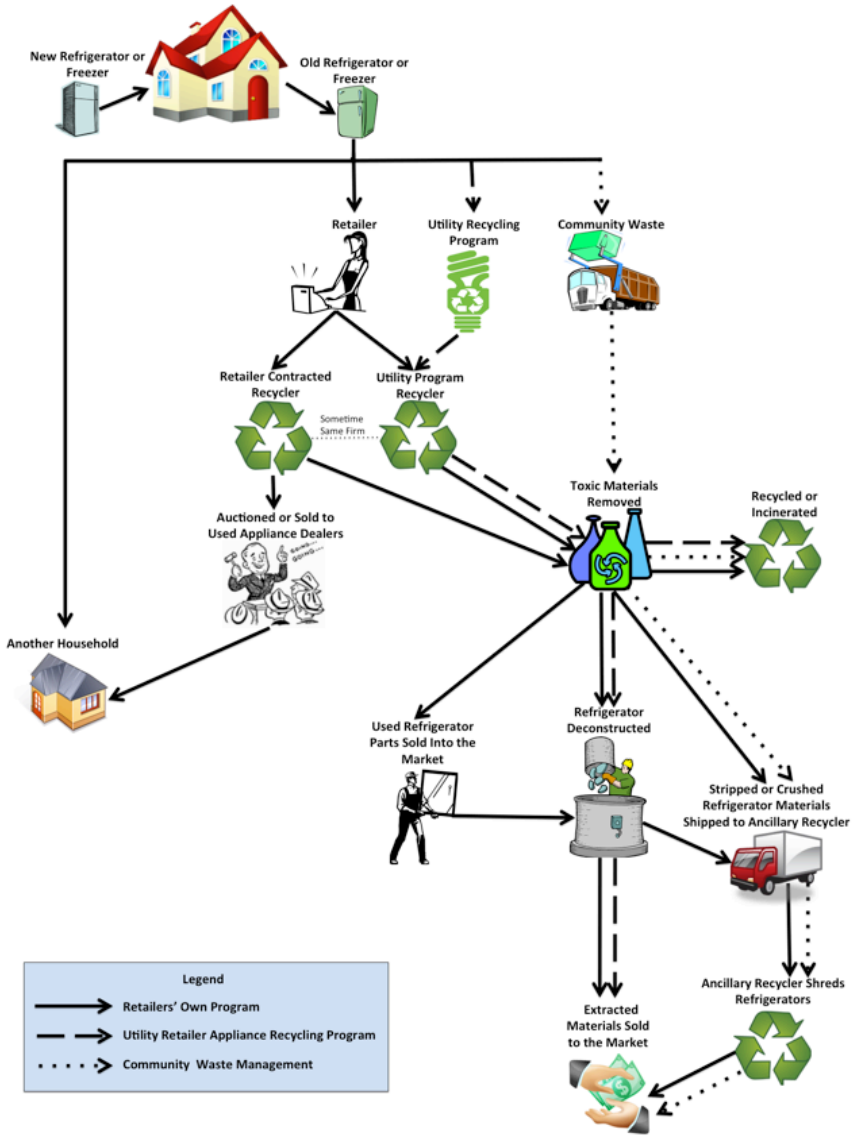
Path Two: Removed by a Utility Sponsored Recycling Program

Refrigerators and freezers recycled through utility sponsored appliance recycling programs are picked-up from the homes of recycling program participants or from a retailer's distribution center by the utility's recycling contractor. At the recycling contractor's facility, the refrigerants are drained and mercury switches and capacitors containing toxic materials are safely removed. The recycler deconstructs the entire unit at their facility extracting any usable materials like glass, foam, aluminum, and plastic, and sells them into the market. The box, the compressors and the coils may be handled separately because of their steel and copper content to maximize their value.

Path Three: Removed by a Retailer and then Sold or Recycled

When a customer buys a new refrigerator, most retailers will remove the old appliance for the customer for free or for a small fee. Disposal of appliances involves a cost to retailers and they are therefore interested in disposal methods that will minimize that cost or turn removal into a revenue stream. This need is further complicated by California requirements that firms that maintain and dispose of refrigerators and freezers be licensed and follow strict guidelines in order to minimize the green house gas effects of refrigerants. Although not a front burner issue, retailers and manufacturers are wary of the potential for disposal of old units to become a future liability.

The prototypical approach for this disposal method is that the retailer's logistics firm[2] removes the old unit from the home of a new unit purchaser and takes it to the retailer's distribution center where it is removed by a contracted recycling firm. The term "recyclers" includes firms that sell used units back to the market as well as firms that deconstruct units and recycle the materials.



Source: Innovologie 2012

Figure 3 Tree Showing the Possible Movements of an Old Refrigerator Leaving a Household

[2] Almost all retailers now outsource delivery logistics

Recyclers that sell units back into the market usually selects units that are white, working, less than ten years old, and in good condition to be auctioned or sold to used appliance dealers. In some instances firms may salvage parts for the resale market. Some recyclers actually deconstruct all of the units they receive from retailers but this is difficult to do from an economic perspective.

The remaining units are disposed of in one of two ways. Some of these recyclers deconstruct the units and dispose of the materials in a process similar to the one described for the utility recycling programs.

Alternatively, the units are sold to ancillary recyclers who are major scrap dealers that shred large objects and then sell the resulting materials, which in the case of California is often shipped overseas.[3] In that case, the recycler may select parts and strips the units and/or crushes them for shipping and then transfers them to an ancillary recycling firm.

In some cases the ancillary recyclers will accept intact refrigerators and then remove the refrigerant before shredding. In an interview, one ancillary recycler that shreds units reported that the temperatures are sufficiently high in the shredder so that the chlorofluorocarbons (CFCs) in the insulation are destroyed and emissions from the stack pass US Environmental Protection Agency (EPA) inspection, but we are unable to verify this external of the interview (Reed, et.al. 2010. Proximity to the ancillary recycling facility is a key determinant of whether the contracted recycler crushes the box or not.

Path Four: Removed through a Community Waste Program

The fourth path for disposing of refrigerators and freezers is through a community waste program. After removing the refrigerator or freezer from a home, community waste management programs remove the refrigerant and other toxic materials. The units are usually stripped or crushed and shipped to an ancillary recycler that shreds the unit and sells the useable extracted materials into the market.

Extracted Refrigerator and Freezer Materials – Where Do They Go?

Refrigerators and freezers contain both toxic and non-toxic elements. There are materials that can be directly sold into the materials market or shredded and then sold into the materials market and toxic materials that can be reclaimed or incinerated according to the Clean Air Act. Figure 4 is a general depiction of the flow of deconstructed refrigerator/freezer elements for appliance recycling programs.

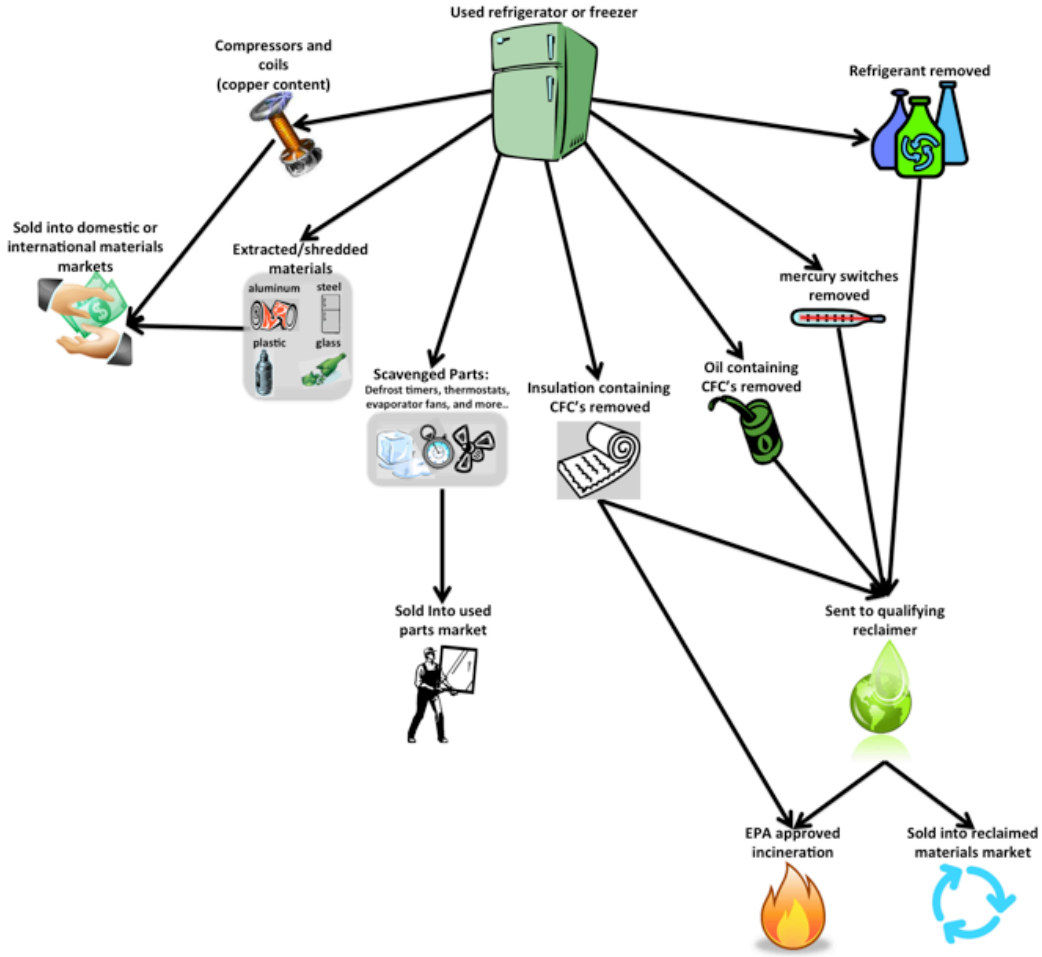
The toxic elements found in refrigerators and freezers come from polychlorinated biphenyls found in capacitors and mercury from switches in older units. In addition, CFCs, which are very potent green house gasses, are contained in the refrigerant, found in the compressor oil, and in the foam insulation where they were used as blowing agents.

The recycling contractors that serve utility sponsored appliance recycling programs in California comply with Section 608 of the Clean Air Act requiring that CFC containing refrigerants be removed from the appliance before disposal or recycling and in a manner that minimizes the release of CFCs and prohibits knowingly ventilating or releasing it into the environment (Cornell University). It also requires that recovery and recycling equipment be able to recover 90 percent of the refrigerant from a unit that has an operating compressor (USEPA, 2011).

3 Most of this material has been sent to China where there is a strong market for scrap steel. However, in recent months prices in this market have declined with the slowdown in the Chinese economy.

The refrigerants are captured and are sent to a US EPA certified reclaimer (USEPA, 2010) that either reclaims the refrigerants and sells them into the market where they can be reused in older equipment or incinerates it to US EPA standards. The insulation containing the HFC blowing agents may be incinerated in an approved incinerator or decomposed to capture the HFCs and an inert powder. The HFCs are then sent to a reclaimer.

The Act also applies to refrigerant containing oils that are present in refrigerators and freezer compressors. The recyclers remove the oil before demanufacturing the appliance. The recycler sends the oil to be refined effectively removing the refrigerants and then the oil and the separated refrigerants are either sold for reuse or incinerated (American Recycler).



Source: Innovologie 2012

Figure 4 The Flow of Parts and Fluids from Deconstructed Refrigerators

Switches containing mercury are considered universal waste (State of California, 2005) and US EPA also regulates their disposal. The California Department of Toxic Substance Control has outlined the specifics of how to dispose of mercury switches from appliances for recyclers. Universal waste in small quantities must be sent to a facility authorized to collect it and must meet the following requirements:

- It may not be stored for more than one year (date received and shipped must be documented)
- It must be labeled as universal waste

- It must not be treated (any activity changing its characteristics) except in the case of cleaning up an accidental release
- If released it must be cleaned-up and repackaged properly
- Employees must be trained in proper handling
- Shipping papers must be prepared accordingly
- It must be transported in the recyclers own vehicle or in any common carrier allowed by US DOT and the State of California
- It must be shipped to a qualifying destination facility
- Records of shipments and receipts must be kept (State of California 2008)

Recyclers for the major utility sponsored appliance recycling programs in California store and ship the mercury switches according to these requirements. The qualified reclamation entity either sells the mercury into the reclaimed materials market or incinerates it according to EPA standards.

Used Parts, Materials, and Shredded Materials

After the toxic materials are removed from the units some recyclers scavenge the units for parts that are in good condition and that are salable (e.g., defrost timers and thermostats not containing mercury, evaporator fans, and brackets).

Compressors and refrigerator coils are removed from the units and sold for their copper content. The compressors may be sold in the international market where they may be disassembled to recover the copper. Aluminum, glass and plastic are sorted and sold primarily to domestic markets. The steel is sold for scrap and typically ends up in a shredder, where it may be sent to China, and recycled into new products. As a result of these processes, the materials from appliances removed through utility programs do not end up in landfills.

Recycling outside of the utility programs may result in some materials going to landfills. As noted earlier, refrigerators and freezers recycled through ancillary recyclers may be shredded before the foam insulation is removed.

An additional point is that the value of the materials can vary greatly. The price of CFCs was relatively high following the implementation of the Montreal Protocol when CFCs could be recycled and used in certain equipment that needed it. However, as this equipment has been replaced by newer equipment not requiring CFCs, the price for CFCs has declined. For the common replacement of CFCs, a molecule of HFC-134a is 1300 times more potent than a molecule of CO_2. Thus, the 0.6 pounds of refrigerant evacuated from a refrigerator has roughly the global warming potential of 800 pounds of CO_2. In the middle of the last decade the price for recycled steel was quite high because of the demand for it from China, but as their economy slowed the price decreased. The price of copper has varied as well. The important take away is that the value recyclers can obtain for materials in the market varies which means that their revenues fluctuate with the price of materials which influences the cost of their services.

Economics Drives Retailer Recycling

Concerns about the costs of recycling drive the choices that retailers make about disposing of appliances. For example, a retailer receives whatever the retailer is able to charge for the removal of an appliance, plus an amount from the recycler, less the cost associated with the haulaway, and the costs of handling the unit at the distribution center.

Retailers may charge a small amount to remove an old refrigerator, for example, $10. This amount may vary with the market and the fee may be waived to close the sale on a new refrigerator. Retailers that sell to recyclers use revenue from recyclers to offset the haulaway costs of recycling other

materials such as cardboard, pallets, carpet, mattresses, and other items where the value of the materials is not sufficient to pay for removal and disposal.

A recycler may pay the retailer $10 to $15 per unit for recycling, but the amount the recycler can pay is limited to the value of the materials that can be recovered (see above) and the value of the 10 to 25 percent of the refrigerator units that can be sold in the secondary market. That value has to cover logistics, dismantling, selling materials, and profit. A secondary recycler may impose a nominal charge for accepting a unit or may recycle units without cost if the value of materials is sufficient to cover operations. County and municipal waste haulers may require a homeowner to obtain a sticker or permit costing from $15 to $50 that is placed on a bulky item before it can be removed. That amount covers haulaway and recycling.

Recyclers can sell working and desirable units to used refrigerator dealers for $40 to $50 per unit. The amount a recycler can charge is limited by what used dealers are willing to pay to ensure that the costs associated with preparing the unit for sale, selling the unit, delivering the unit, offering some minimal service and warranty and making a profit. The used dealer may also need to bear the costs of removing and disposing of an old unit.

Used refrigerator dealers generally sell units to end-use customers in a range from $125 to $300. The upper end of this range is limited by the cost of a new 18 to 20 cubic foot top freezer automatic that can be purchased from new appliance retailers in the range of $300 to $400 on a payment plan and units offered by individual sellers of their old refrigerators through sources such as Craigslist and PennySaver.

Historically, independent dealers sold new and used appliances and took "trade-ins" and serviced appliances. Some of these dealers had contracts to remove appliances from communities and some advertised and got paid or hauled old appliances for free. These dealers selected usable units for resale and disposed of the rest. Now, because of disposal costs used dealers are reluctant to take anything other than a salable unit.

Currently, used dealers typically purchase in the used market and resell refrigerators. Their sources are first level recyclers who sell units from retailers and the Salvation Army, which is now the only community organization that accepts used refrigerators in California. The Salvation Army requires that the units be working with the best units being placed in their stores for resale and the remainder placed for wholesale to used appliance dealers. Other organizations have stopped taking donations of refrigerators and freezers because it is difficult to break even by selling some and disposing of the rest. A key issue is dealing with extracting and selling the refrigerant.

Earlier, we documented the decline of used appliance dealers. Many of the used dealers who are still in business report that they have difficulty getting good used units. Many dealers are nearing retirement and are getting out of the business as the dynamics of the market have changed. Some blame the utility recycling programs for the decline. While utility programs may account for some of the decline, there are numerous other reasons such as the nationalization of service providers like Sears, GE, and other newly forming national service organizations, large retailers who are able to sell new units at very competitive prices, appliance warranty contracts that reduce the repair business for independent dealers, large retailer disposal practices, new appliance dealer financing, sales of used units outside the US, the need to provide some warranty on used units, and a host of other reasons.

Finally, there is the question of the market for used appliances. Small apartment building owners purchase a very small number for use in apartments although this practice seems to be declining. Householders purchase them for secondary use. Some are purchased for primary use in dwellings. Many others are placed in second dwellings such as cabins and lodges.

While there is the indelible image of the used appliance dealer preying on low-income populations, the image fits less and less well with reality. Many low-income families own their own refrigerators and move them when they move. In Los Angeles and vicinity there are many apartments that rent without a refrigerator. Another dynamic at work is that used appliances now frequently change

hands directly between parties with transactions arranged through sources such as Craigslist and the PenneySaver.

Large Retailer Disposal Practices

The prototype for large retailer disposal of appliances has been emerging over the last decade or more. With an extensive history of appliance sales, Sears has long recognized the costs of disposal and has worked diligently to turn waste disposal from a cost center into a profit center. The units Sears removes, except for the very small percentage of units that are recycled through utility collaborations, are sold to recycling companies who dispose of units in pretty much the prototypical fashion described above. The Sears' approach has evolved over the years and the pattern is generally consistent nationwide, although the recycling companies involved vary in different parts of the country.

Other major retailers are relatively new to the appliance business (e.g., Best Buy, Lowe's, and Home Depot) and their practices with respect to appliance and refrigerator disposal have emerged over recent years. In California, Best Buy's approach to refrigerator disposal aligns well with the prototypical Sears model. They seem to follow the same pattern nationwide.

Lowe's seems to be converging on the prototypical approach nationwide. In the recent past, the practices of Lowe's stores varied by locality with some stores letting, or even encouraging, the logistics contractor to dispose of old refrigerators as well as other waste. In other localities old units were returned to stores and store managers oversaw their disposal. Very recently, Lowe's has begun to regularize disposal of old appliances across its stores with a national contractor responsible for all types of waste that subcontracts appliance disposal. Procedures are increasingly similar to those of the prototype described above

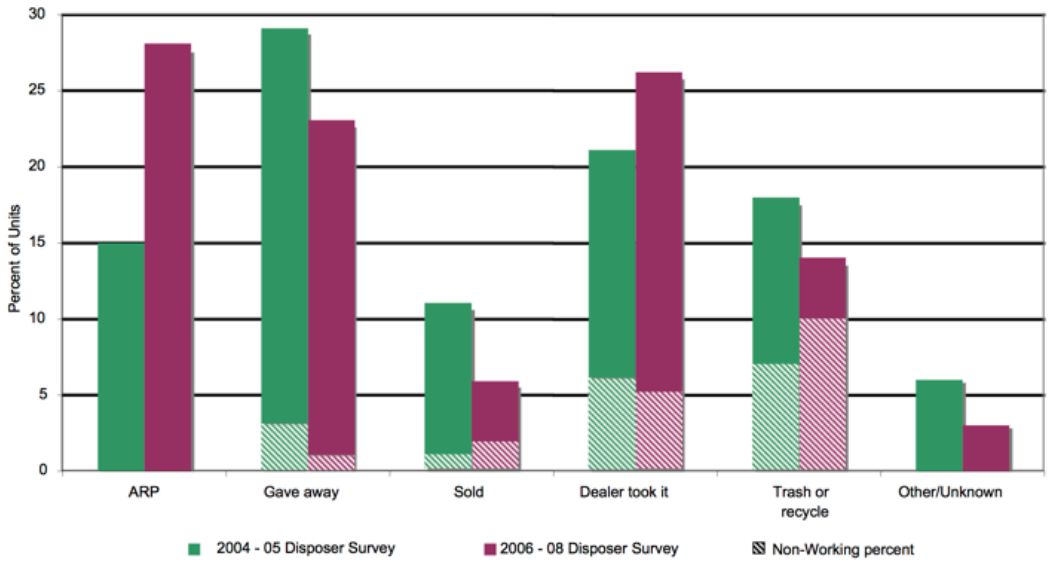
Home Depot is expanding an agreement with GE logistics nationwide that requires 100 percent dismantling of refrigerators and freezers. Under this agreement units collected from customers do not return to the market. This is a result of GE's participation in Environmental Protection Agency's (EPA) Responsible Appliance Disposal (RAD) program. The RAD program "is a voluntary partnership program that began in October 2006 to help protect the ozone layer and reduce emissions of greenhouse gases. As part of the RAD program, partners recover ozone-depleting chemicals from old refrigerators, freezers, window air conditioners, and dehumidifiers (EPA, 2012)." According to GE, as of September 2011, they had partnered with Appliance Recycling Centers of America (ARCA) to recycle refrigerators from Connecticut, Pennsylvania, New Jersey, New York, Maryland, West Virginia, Vermont, Delaware, Virginia, North Carolina, and Rhode Island, at ARCA's Pennsylvania based recycling center (Irene 2012). That center receives used appliances of all kinds from Home Depot as well as other sources. That center drains the refrigerants and removes toxic components from old refrigerators and freezers and then uses a fully automated process to shred the units and separate the materials: steel, HCFCs, non-toxic residue from insulation, aluminum, copper, and plastic that can be sold in "local" markets.

It is important to note that the appliances logistics teams that remove refrigerators for retailers are not usually the same as the logistics teams that handle distribution center-to-store or store-to-store product logistics. They are separate and mostly contracted teams. In turn, the contractors may subcontract to smaller local logistics contractors. For example, Sears, Home Depot, LG, Maytag, and Whirlpool each have a contract with Home Delivery America (May 2012a). Home Delivery America provides services such as in-home delivery, customizable routing systems, customer service, inventory management, and automated call systems. They hire independent contractors that meet their insurance and other qualifications and that already own a qualifying delivery truck. The independent contractors are required to have at least one other delivery person on their teams (May 2012b). The fact that the delivery personnel are not employees of the retailer may complicate matters with respect to instilling discipline with regard to the removal and recycling of refrigerator units.

The Volume of Appliances in Used Refrigerator Removal Channels

Because most of the large players in the new refrigerator market provide some type of fee based or promotional delivery and removal services to purchasers, it is widely assumed that new appliance dealers are a major source of refrigerator removals. However, data from the 2004-05 Residential Appliance Recycling Program disposer survey (ADM 2008) (three service territories) and the 2006-08 Appliance Recycling Program disposer survey (Reed 2010) in the Southern California Edison (SCE) service territory show that only about a quarter of households replacing refrigerators have the appliances removed by a retailer. Refrigerators that leave the home in California flow through various channels to new owners or are dismantled with some or all of the materials recycled. The purchase of a new refrigerator does not necessarily result in a refrigerator leaving the home.

As displayed in Figure 5, the 2004-05 and the 2006-08 ARP surveys show that for the SCE service territory, ARP removed 15 and 28 percent of used refrigerators in the respective surveys. Appliance dealers removed between 21 and 26 percent of the refrigerators, another 39 and 29 percent of refrigerators were given away or sold. Community trash or recycling programs removed 13 and18 percent of used units. The remainder (3 percent and 6 percent) was removed through unknown means. Thus, the assumption that dealers remove most of the refrigerators is not supported.



Source: Innovologie LLC 2010

Figure 5 Refrigerator Disposal Channels from the 2004-5 and 2006-8 Disposer Survey

Figure 5 also shows the number of non-working units that were reportedly removed (areas with diagonal shading). Very few of the units that were given away or sold were reported to be non-working. For the units that went to trash or were recycled, about a third of units in the 2004-05 survey and more than two thirds of the units in the 2006-08 survey were reported to be non-working. Sixty-six and 75 percent of the units removed by the retailer in the 2004-05 and 2006-08 surveys were working units. Between 10 and 25 percent of the working and nonworking units removed by dealers were reportedly returned to the market.

These data also show that even with the ARP, 38 and 29 percent of refrigerators were either given away or sold. Further, one cannot assume that the refrigerators removed by ARP would have been removed by dealers or sent to the trash. The data from the 2004-05 and 2006-08 surveys show that if

ARP did not exist, 56 and 55 percent of all replaced units respectively would have remained in the market.

Summary of Findings

Our paper describes the linkages between the new and used refrigerator and freezer markets in California. Over the last 15 years about 950,000 refrigerators have been sold for use in occupied households annually. A small number of large retailers dominate the new appliance market nationally. This represents an underlying annual refrigerator replacement rate of approximately seven percent of households with a slightly greater rate of replacement when the housing market is strong. It is estimated that in the absence of major utility sponsored appliance recycling programs and with large appliance retailer recycling, approximately 55 percent of working refrigerators would remain in the market. In other words, the supply of old refrigerators is constantly replenished, and the rate of replenishment is such that the number of non-primary units can increase. There is potential for the number of households with second refrigerators to increase. Data presented in our paper indicate that this has occurred in recent years.

Utility sponsored appliance recycling programs remove refrigerators and freezers for households that are not replacing a unit and for households that are replacing a unit but do not have a unit removed at the time of purchase. Retailer programs remove refrigerators from about 25 percent of households. Ten to 25 percent of those units are likely to return to the market. Two major utilities in California have conducted trials to test the concept of augmenting retailer's efforts to remove refrigerators at the time of delivery of a newly purchased refrigerator. There appears to be room in the market for an effective utility retailer recycling program that encourages customers to surrender units at the time of purchase to avoid their becoming inefficient secondary units.

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