



# ENERGY STAR Market & Industry Scoping Report

## Miscellaneous Residential Refrigeration Products

### April 2014

U.S. Environmental Protection Agency (EPA) consistently looks for new opportunities to expand ENERGY STAR to new product categories that will deliver significant benefits to consumers and the environment in the form of energy and dollar savings plus greenhouse gas reductions. A key step in this evaluation is the development of a scoping report that provides a snapshot of the product market, energy use, and savings potential associated with an ENERGY STAR program for the scoped product type. EPA uses scoping findings to prioritize product specification development work. While scoping reports are drafted primarily for internal evaluation purposes, and are not intended to be exhaustive but rather a guidepost for the ENERGY STAR program, EPA makes the reports available with the interest of benefiting other efficiency program evaluating similar opportunities. For more information about the ENERGY STAR specification development process, go to: [www.energystar.gov/productdevelopment](http://www.energystar.gov/productdevelopment).

## 1. Product & Technology Overview

This report considers several different types of residential refrigeration products, including:

- wine chillers/beverage centers, including hybrid products;
- other refrigerators (using absorption and thermoelectric technology); and
- residential ice makers

The ENERGY STAR Residential Refrigerator and Freezer program does not presently cover the products addressed in this report.<sup>1</sup> However, some products may already be subject to Federal standards if they meet the applicable U.S. Department of Energy (DOE) definition, i.e., for an electric refrigerator, electric refrigerator-freezer, or electric freezer. Additionally, DOE is presently conducting a rulemaking that may consider standards and test procedures for product categories discussed in this report. Most recently, a Supplemental Proposed Determination was released on October 31, 2013.<sup>2</sup>

### Wine Chillers, Beverage Centers & Other Refrigerators

Wine chillers (also referred to as wine refrigerators or wine coolers) are used by consumers to store and refrigerate wine. Traditionally, the wine chiller may have been considered more of a luxury product, but this perception is changing as wine increases in popularity and affordable products enter the market. Wine chillers generally operate at higher temperatures than standard refrigerators, are available in a variety of sizes, usually have a glass door, and include elements to reduce vibration and UV rays in an effort to enhance wine preservation. Additionally, there are also hybrid products, which are refrigerators or freezers that also include a compartment designed to operate at a warmer temperature than is used for fresh food storage, i.e., specifically, to store wine.

Beverage centers are refrigeration products that are generally marketed as products intended for cooling and storing beverages of various types, not limited specifically to wine; they also

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<sup>1</sup> ENERGY STAR scope is addressed in an FAQ and the Version 5.0 Refrigerators and Freezers Program Requirements.

<sup>2</sup> Information on this DOE Rulemaking is available here:

[http://www1.eere.energy.gov/buildings/appliance\\_standards/rulemaking.aspx/ruleid/71](http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/71)  
ENERGY STAR Market & Industry Scoping Report: Miscellaneous Refrigeration Products

commonly have glass doors. As a result of this intended use, they appear to typically have a wider range of temperatures. An initial review of a number of products from multiple manufacturers indicates that beverage centers generally are designed to store items between 33°F and 54°F, while refrigerators are designed to store food products between 32°F and 46°F. Beverage center manufacturers appear to mostly recommend storage temperatures of 39°F. Some of these products are already regulated by DOE as refrigerators if they have a temperature range which extends below the requisite temperature for safe food storage (39°F). (See the definition of “electric refrigerator” at 10 CFR 430.2)

Kegezers are a related type of refrigerator with specialized features allowing them to chill, store and dispense keg beer. A review of products on the market today indicates they can operate anywhere from 33°F – 43°F. As with beverage centers, this suggests some may be already regulated by DOE as electric refrigerators if they are capable of maintaining a storage temperature below 39°F.

The three types of cooling technologies found in these products are listed and discussed below. In addition to products specifically designed to store wine or beverages, thermoelectric and absorption refrigerators are also available in the U.S. and have been considered in this report.

- **Vapor compression**– Utilizing technology similar to traditional refrigerators, a compressor-driven refrigeration cycle is used to cool the compartment.
- **Thermoelectric**– A thermoelectric Peltier device is a ceramic plate that becomes cold on one side and hot on the other when a low voltage electric current is applied to it. This technology is generally found in smaller products. Due to the lack of compressor, thermoelectric units are usually described as quieter and some sources report the lack of vibration is preferable for wine storage since it results in fewer disturbances of the sediments in wine bottles.<sup>3</sup> They provide much more limited cooling capacity, however, relative to vapor compression units.
- **Absorption**– Uses a heat source, powered either by electricity or fuel (e.g. natural gas or propane), to provide the energy needed to drive the cooling system. Absorption refrigeration products use the ammonia-water absorption cycle to cool the storage cabinet. Absorption technology does not appear to be used extensively in wine chillers. Instead, it is more common in hotels (i.e., mini-bars, where the quieter operation is valued) and mobile applications. These units are also generally more expensive.

### Residential Ice Makers

Residential ice makers are products designed to make and store ice. These products consist of an insulated compartment, a refrigeration system, and an automatic ice maker. Some residential ice makers are portable, i.e., designed to sit on a countertop. Because they are not connected to a water line, they need to be filled manually. Other ice maker products are designed to be permanently installed with a water supply and usually a drain (e.g., underneath a counter) and could be either freestanding or built-in. The technology incorporated into these products can resemble the automatic ice makers found in refrigerator-freezers or commercial ice makers.

Commercial ice makers are covered by the DOE and Natural Resources Canada (NRCAN) regulatory programs. These products are defined as having an ice harvest rate between 50 and

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<sup>3</sup> For example, see: [http://www.winecoolerdirect.com/article?cgid=Wine\\_Refrigerators&aid=wine-fridge-faq#thermoelectric](http://www.winecoolerdirect.com/article?cgid=Wine_Refrigerators&aid=wine-fridge-faq#thermoelectric)

2,500 lb/day. Therefore, a residential ENERGY STAR ice maker category might be differentiated as having a smaller ice harvest rate (e.g., less than 50 lb/day).

## 2. Market Assessment and Usage Assumptions

### Existing Stock

Using the Amazon Mechanical Turk surveys, the Lawrence Berkeley National Laboratory (LBNL) collected U.S. household data on the presence, number, type and usage of product types discussed in this report.<sup>4</sup> Based on this data, the study estimated that approximately 11.1 million households (9.5% of total U.S. households) have a wine chiller or beverage center. An estimated 60% of those households have a wine chiller rather than a beverage center. Of the wine chillers/beverage centers in use, 85% have thermoelectric technology and the remaining 15% use vapor compression technology. LBNL did not find any products in households using absorption technology. As noted above, absorption refrigeration is more common in hotels and outdoor applications such as recreational vehicles and boats.

About 4.6% of U.S. households are estimated to have a residential ice maker. An estimated 69% of residential ice makers are portable units. Table 1 shows the estimated stock for different product types. For several categories, there is a higher uncertainty and in these cases a range is also shown. The hybrid category includes refrigerators, refrigerator-freezers or freezers with compartments that are designed to operate at a warmer temperature than a fresh food compartment (e.g., for wine storage).

**Table 1: U.S. Stock<sup>5</sup>**

Product/Technology Type	Estimated U.S. Stock (millions)	
	<i>Average Estimate</i>	<i>Possible Range</i>
<b>Wine Chiller – Total</b>	<b>12.36</b>	
Vapor Compression	1.86	
Thermoelectric	10.5	
<b>Hybrid Products</b>	<b>4.5</b>	
<b>Other Refrigerators – Total</b>	<b>3.3</b>	
Thermoelectric	2.9	1.2 - 4.4
Absorption	0.4	
<b>Residential Ice Maker</b>	<b>5.5</b>	2 - 8.7

Available estimates on U.S. annual sales are summarized in Table 2. The estimated average lifetime for a wine chiller, based on the LBNL survey data, was about 4.5 years. The survey also suggested that the average lifetime of a residential ice maker was about 1.7 years, which seems surprising low, especially considering that most products are purchased for over \$100 (see next section). For hybrid products, the average lifetime would likely be closer to a full-size refrigerator or freezer. In the last residential refrigeration rulemaking, DOE estimated average lifetimes of 17 years for refrigerators and 22 years for freezers. Appliance Magazine estimates an average life expectancy (based on first-owner use) to be 13 years for refrigerators and 12 years for freezers.<sup>6</sup>

<sup>4</sup> Lawrence Berkeley National Laboratory. (2013). U.S. Residential Miscellaneous Refrigeration Products: Results from Amazon Mechanical Turk Surveys. Accessed here: <http://escholarship.org/uc/item/26s847hd#page-4>.

<sup>5</sup> DOE October 2013 Supplemental Notice of Determination. Stock estimates are mostly derived from the LBNL survey data; stock of absorption refrigerators was informed by data by a manufacturer.

<sup>6</sup> Appliance Magazine 2014. The U.S. Appliance Industry Market Value, Life Expectancy, and Replacement Picture 2013.

**Table 2: Annual U.S. Sales<sup>7</sup>**

<b>Product/Technology Type</b>	<b>Estimated U.S. Annual Sales</b>
<b>Wine Chiller - Total</b>	<b>2,710,000</b>
Vapor Compression	410,000
Thermoelectric	2,300,000
<b>Hybrid Products</b>	<b>240,000</b>
<b>Other Refrigerators – Total</b>	<b>690,000</b>
Thermoelectric	600,000
Absorption	90,000
<b>Residential Ice Maker</b>	<b>2,200,000</b>

### **Consumer Usage Behavior**

As part of its analysis, LBNL found that most owners of a wine chiller or beverage center accessed the product less than they would a refrigerator. Responses on door openings ranged widely from 10 or more times per day to once a month or less; the median response was reported as slightly less than once per day. DOE also assumed portable residential ice makers would only be plugged in 50% of the year.

### **Pricing**

The price of a wine chiller or beverage center depends on a variety of factors. The price range found at typical retailers ranges from \$50 to over \$5000.<sup>8</sup> Retail price is influenced by variables such as size, brand, styling/finish, type (i.e., built-in or free-standing), shelving, door options, cooling technology, digital vs. manual temperature controls, the inclusion of additional temperature zones (e.g., separate spaces for storing red and white wines). The most common purchase price is between \$75 and \$350.<sup>9</sup>

LBNL found that approximately half of residential ice makers were purchased for a price between \$100 and \$250.<sup>10</sup> Only about 5% of products were purchased for less than \$100; some products cost as much as \$3,000. As with other products, the price depends on a variety of factors such as portable vs. non-portable, styling/finish, quantity of ice production (speed at which it can be produced), and type of ice.

### **U.S. Consumer Preferences**

Within the LBNL survey, wine chillers/beverage centers with a capacity of 19 bottles or less (corresponding to up to 2.3 cu-ft in volume) are most common (reported by 77% of purchasers).<sup>11</sup> Initial research suggests that key considerations for purchasers are temperature stability and close control of the humidity levels. Other considerations for consumers are capacity, multiple temperature zones, shelving, UV-protective glass, and vibration. While there is limited data on the energy use of products, some sources may be mistakenly suggesting that thermoelectric technology is the most energy efficient option for a wine chiller.<sup>12</sup>

<sup>7</sup> DOE October 2013 Supplemental Notice of Determination.

<sup>8</sup> Retail websites reviewed include Best Buy, The Home Depot, Lowe's, and Sears.

<sup>9</sup> Lawrence Berkeley National Laboratory. (2013). U.S. Residential Miscellaneous Refrigeration Products: Results from Amazon Mechanical Turk Surveys. Accessed here: <http://escholarship.org/uc/item/26s847hd#page-4>.

<sup>10</sup> Ibid.

<sup>11</sup> Ibid.

<sup>12</sup> See, for example: <http://www.foodandwine.com/articles/ultimate-refrigerator-buying-guide/sidebars/2>

LBNL found that approximately one third of wine chiller/beverage centers use vapor compression and the remaining two thirds used thermoelectric technology; the type of technology was also strongly correlated with capacity. Smaller products (capacity of 19 bottles or less) predominantly use thermoelectric technology, while larger products were more likely to use vapor compression. The survey results also indicated a significant number of customers did not know the type of technology their wine chiller/beverage center used, or they were not accurate in identifying it.

To supplement automatic or manual ice making in a freezer, consumers can purchase portable ice makers or larger built-in ice makers. DOE found that over two-thirds of residential ice makers are portable ice makers. These offer added flexibility in use, i.e., can be transported to a party or event. An initial review of consumer comments on ice maker products shows that consumers are primarily concerned with the quality and type<sup>13</sup> of ice produced, and the speed at which it is produced. Product energy use information was not found and thus not surprisingly, energy efficiency did not rank highly in consumer commentary/reviews for any of the products reviewed.

### ***3. Miscellaneous Refrigeration Products Test Procedures and Standards***

#### **U.S. Department of Energy Test Procedure**

Currently, there is no dedicated Federal test procedure to measure the energy consumption of miscellaneous refrigeration products. On October 31, 2013, DOE issued a preliminary determination that a set of miscellaneous refrigeration products, including those that do not have a compressor, qualify for coverage under the Energy Policy and Conservation Act (EPCA). If DOE issues a final determination that these products are covered products, the Department will then consider developing the test procedures. Manufacturers have already expressed support for the adoption of the California Energy Commission (CEC) test procedure, which is an amended version of the current refrigerator test procedure (10 CFR Subpart B, Appendix A1).<sup>14</sup> This test procedure is a closed door test at a higher temperature (90F). However, as noted earlier, consumers appear to open the door of a wine chiller or beverage center less frequently than they would a standard refrigerator. Considering this, the CEC test method applies a factor of 0.85 to the energy use that would be measured in DOE refrigerator test procedure (Appendix A or A1). In the October 2013 Proposed Determination, based on additional testing performed, DOE suggested a usage factor of 0.55 may be more appropriate. DOE also published a Framework document in February 2012 that discussed issues, analysis and the process that DOE was considering to develop efficiency standards for wine chillers and other miscellaneous refrigeration products.

For residential ice makers, there is no known test procedure. It is unclear at this time how applicable the commercial ice maker test procedure would be to a residential product. The DOE is also developing also developing an ice making test procedure for residential refrigerator-freezers that may have applicability for stand-alone residential ice makers.

#### **U.S. Federal Energy Conservation Standards**

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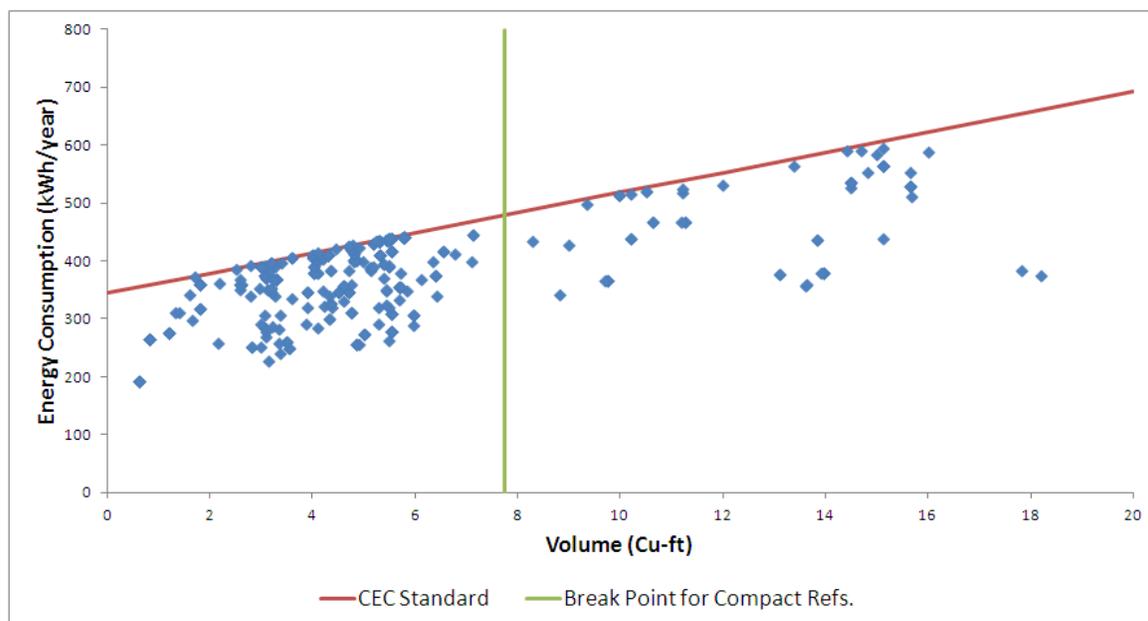
<sup>13</sup>There were two primary types of ice found: clear ice and frosty ice. Clear ice resembles restaurant quality ice that has had the imperfections removed. Frosty ice includes the imperfections and is therefore less desirable to some consumers.

The current energy efficiency performance metric for all refrigerators is annual energy use (kWh/year). This metric is likely to also be applicable for wine refrigerators, beverage centers, kegerators, and ice makers. For residential ice makers, the same metrics used for commercial ice makers could also be considered. These metrics include the maximum energy use (kWh/100 lb ice) and maximum condenser water use (gal/100 lb ice).<sup>15</sup>

#### 4. Energy Efficiency Assessment

There appears to be significant variation in the energy efficiency of wine chillers. To demonstrate the current variation in energy use, Figure 1 shows the annual energy use of wine chillers and beverage center products relevant to the U.S. market. This data is from the listings maintained by the California Energy Commission (CEC) and NRCAN.<sup>16</sup> The red line in Figure 1 represents the California Title 20 minimum standard for wine chillers.<sup>17</sup> There appears to be fairly considerable differences (up to 46%) in the energy efficiency of products presently on the market.

**Figure 1: Annual Energy Consumption by Volume**



Note: that the energy use of products is based on the 0.85 usage factor in the CEC regulations; the energy use of models would be approximately 35% lower if a lower usage factor (0.55) is instead used.

Table 3 also summarizes information on the measured energy use of product in categories of interest, from DOE’s 2013 Proposed Determination.

<sup>16</sup> The CEC dataset may be pulled from the following website: <http://appliances.energy.ca.gov/AdvancedSearch.aspx>. The NRCAN database may be found at the following website: <http://oee.nrcan.gc.ca/pml-lmp/index.cfm?action=app.search-recherche&appliance=REFRIGERATORS>.  
<sup>17</sup> California Title 20 minimum standards regulate the energy efficiency of wine chillers sold within the state of California.

**Table 3. Measured Energy Use of Wine Chillers and Related Product Types**

Product Type/Technology (Number of units tested)	Measured Energy Use (kWh/yr)	Testing Notes
Vapor Compression Wine Chillers (8) Rated capacities of 17-147 bottles	161-480	CEC test procedure. Energy use in field testing and closed door testing at 72F room temperature was about ½.
Thermoelectric Wine Chillers (3) Rated capacities 6-28 bottles	413-550	CEC test procedure, but 2 of the units could not maintain required cabinet temperature.
	142-664	Tested at 72F room temperature with a 1.2 factor to account for door openings.
Thermoelectric Wine Chillers (6) Rated capacities 0.6 to 4.9 cu-ft	183-803	Tested under field conditions, approx. 70F average ambient temperature.
Thermoelectric Refrigerators (2)	566	DOE's estimate of field energy use; neither unit was able to maintain compartment temperature of 39F in 90F setting only one maintained this in a 72F setting.
Absorption Refrigerators (1) 1.4 cu-ft	553	DOE's estimate of field energy use; product tested maintained the 39F temperature in a 72F setting (but not 90F)

There are no known databases of residential ice maker energy use or energy efficiency. DOE reported the results of several models that had been tested (based on approximately 4lb of ice production, per day). The portable ice maker tested used 139 kWh (assuming the product is used to make ice 50% of the year), and the non-portable ice maker tested used 842 kWh.

**Savings Opportunities**

The following section discusses technology options to increase the energy efficiency of the miscellaneous refrigeration products discussed in this report. Consumer Reports notes that wine chillers are not particularly efficient and that their testing indicates some models use more than twice as much as others (roughly consistent with the data in the CEC and NRCAN databases, presented in Figure 1), and even as much as a 18 cubic foot refrigerator.<sup>18</sup>

In general, vapor compression technology is understood to provide the greatest energy efficiency, when compared against absorption and thermoelectric technologies. The DOE technical analysis in support of the last standards rulemaking for refrigerators and freezers included thermoelectric technology. DOE reviewed it as an alternative to the traditional vapor compression refrigerator models but noted it was considerably less efficient than vapor compression cycle and therefore removed it from further consideration. Thermoelectric products and absorption products may be able to utilize some of the design options presented below for vapor compression products, such as increased insulation, vacuum-insulated panels, and efficiency improvements to the door. However, more research is needed to understand if

<sup>18</sup> Consumer Reports. Accessed February 28, 2014 at: <http://www.consumerreports.org/cro/wine-chillers/buying-guide.htm>

improvements could be made to the overall design of the thermoelectric system to improve its efficiency.

For vapor compression products, increased energy efficiency can be obtained through use of similar techniques as used in standard refrigerators. The DOE analysis as part of the last Federal standard revision for refrigerators includes the following options for increasing efficiency.

**Table 4: Efficiency Design Options for Vapor Compression Type Products**

Design Options by Product Class	PC3	PC5	PC7	PC11
Increased Insulation Thickness				X (3/4 inch)
Isobutane Refrigerant				X
Vacuum-Insulated Panels	X	X	X	X
Improved Compressor Efficiency	X	X	X	X
Variable-Speed Compressor	X	X	X	X
Increased Evaporator Surface Area	X	X	X	X
Increased Condenser Surface Area	X	X	X	X
Brushless DC Evaporator Fan	X	X	X	
Brushless DC Condensor Fan	X	X	X	
Adaptive Defrost	X	X	X	

The technologies used to improve efficiency will vary on the size of the product and in some cases may also depend on the intended use/intallation, e.g., whether the wine chiller is a built-in product. Efficiency design options are included in Table 5.<sup>19</sup> There are a variety of designs that could likely be used to improve energy efficiency, though more research is needed to better understand to what extent these technologies are already in use today and what their associated costs are.

**Table 5: Efficiency Design Options**

Design Option	Efficiency Improvement
Increased Insulation Thickness	A few percent to 10% depending on thickness
Isobutane Refrigerant	Up to 10%
Vacuum-Insulated Panels	30%
Improved Compressor Efficiency	Unknown
Variable-Speed Compressor	4-14% <sup>20</sup>
Increased Evaporator Surface Area	Unknown
Increased Condenser Surface Area	1-2%
Brushless DC Evaporator Fan	60-65% reduction in fan power
Brushless DC Condensor Fan	60-65% reduction in fan power
Adaptive Defrost	3-4%

One significant difference between many wine chillers/beverage centers and standard refrigerators is the use of a glass door. Replacing the glass door with a solid door would likely yield energy savings, however, given the number of products available with glass doors there

<sup>19</sup> Further information from the DOE Technical Support Document may be found [here](#). Pg 5-53 to 5-73.

<sup>20</sup> Energy savings possible from using a two-speed compressor with a multi-speed evaporator and condenser fans.

likely some consumer preference for this design. There are also energy efficient glass door design options, including triple pane glass and the removal of air between the glass panes to create a less thermally conductive vacuum.

While vapor compression technology is presently more energy efficient than the other two technologies discussed, there may be some tradeoffs, particularly for wine chillers. Due to compressor operation, vapor compression products may be somewhat noisier and have more vibration than thermoelectric and absorption products. The noise may be a consideration for some consumers and applications, especially depending on where the product is kept. Some sources suggest that less vibration will better preserve the wine. Vibration from the compressor can be mitigated, but will likely add cost. These tradeoffs would likely warrant some additional research and consideration.

There is less information available as to the potential for energy efficiency improvements in residential ice makers. In written comments to DOE, one manufacturer noted that efficiency improvements for residential ice makers would require a total redesign of the product.<sup>21</sup> This included a redesign of the evaporator, interior, refrigeration chamber, piping and cabinet.

Currently, ENERGY STAR certified commercial ice makers are on average 15% more energy efficient than standard models. In the commercial ice making space there are two equipment design types: air-cooled and water-cooled designs.<sup>22</sup> Commercial ice makers utilize multiple design improvements to improve energy and water efficiency. These include:<sup>23</sup>

- More efficient compressors, fan motors, and water pumps
- More efficient auger motor assembly<sup>24</sup>
- Increased air-cooled condenser surface area
- Improved evaporator insulation
- Harvest-assist devices; and
- Tighter tolerance water valves

## **5. Energy and Cost Savings Potential**

Initial estimates of energy and CO<sub>2</sub> savings for the additional residential refrigerator product categories considered in this report were developed for two efficiency scenarios: 20% and 30% energy savings. As baselines, DOE's annual energy use estimates from the Proposed Determination were used.<sup>25</sup> For a consumer, estimated annual cost savings with an efficient unit would be:<sup>26</sup>

- wine chiller/beverage center: \$6-9 per year;
- hybrid refrigeration products: \$9-14 per year;
- other refrigeration products (thermoelectric, absorption): \$13-19; and
- residential ice maker: \$8-12 per year.

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<sup>21</sup> Comments to DOE's Supplemental Notice of Determination may be found [here](#).

<sup>22</sup> Water-cooled designs are not eligible for the ENERGY STAR.

<sup>23</sup> ENERGY STAR Commercial Ice maker Fact Sheet available [here](#).

<sup>24</sup> Only applies to continuous type systems. Likely less relevant to the residential market.

<sup>25</sup> Specifically, 268 kWh/yr for a wine chiller, 560 kWh/yr for other refrigerators (considering both thermoelectric and absorption), and 357 kWh/yr for residential ice makers.

<sup>26</sup> Assumes a average national electricity rate of \$0.113/kWh.

Assuming that 25% of products were more energy efficient and based on estimated annual U.S. sales presented in Section 2, the first-year savings on a national scale would range from 100 to 150 GWh (assuming 20-30% efficiency level). These savings would translate into annual CO<sub>2</sub> emission reductions between 153 and 231 million lbs per year.<sup>27</sup>

## 6. Key Market Players

### Trade Associations

AHAM is the primary trade association covering refrigeration appliances, including miscellaneous refrigeration products. AHAM aims to enhance the value of the home appliances industry through leadership, public education, and advocacy. AHAM provides services to its members including government relations, certification programs for room air conditioners, dehumidifiers, and room air cleaners; an active communications program; and technical services and research.

### Manufacturers

In the U.S. market a variety of manufacturers offer miscellaneous refrigeration products. In the luxury market, this includes manufacturers such as Bosch, LG, Liebherr, Miele, Perlick, Sub-Zero, U-Line, and Viking Range. Other models are available from Avanti, Danby, Haier, Sanyo, Sunpentown, True Manufacturing, and Whynter. Each of the major manufacturers, Whirlpool, GE, and Electrolux, also offer miscellaneous refrigeration products.

Summit, Marvel, U-Line and Scotsman are the dominant manufacturers in the residential ice making market with other manufacturers accounting for a smaller share of the market.

## 7. Stakeholders and Existing Programs

### North America

In North America, there are currently two programs that cover certain miscellaneous refrigeration products, the CEC and NRCan.

- CEC<sup>28</sup>

Wine chillers with manual defrost	13.7V+267
Wine chillers with automatic defrost	17.4V+344

- NRCan<sup>29</sup>

Wine chillers with manual defrost	0.48AV+267
Wine chillers with automatic defrost	0.61AV+344

There are no currently known programs that incorporate any of the other miscellaneous refrigeration products in North America.

### International Level

#### European Union

<sup>27</sup> Assumes a conversion of 1.54 lbs CO<sub>2</sub> per kWh.

<sup>28</sup> Note: V represents the total volume of the product, which in the case of these products would be the equivalent of the Adjusted Volume due to the lack of a freezer.

<sup>29</sup> Note: Multiplier within the formula is designed for Liters. Converting to cu-ft. brings the formulas in alignment with the CEC standards.

Wine refrigerators are covered under the European Union standards program. Products must meet at least the A+ level under the E.U. labeling scheme in order to be sold. The addition of wine chillers is a recent development and was included as part of the European Eco-Design Requirements for Energy-Using Products. Residential ice-makers were not included in this legislation.

### **Australia**

The Australian Greenhouse Office under the National Appliance & Equipment Energy Efficiency Program commissioned a study into wine storage cabinets in 2004. To date, no further action has been taken by Australia to cover miscellaneous refrigeration products.

## **8. Appendix I: References**

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