



ENERGY STAR® Program Requirements Product Specification for Residential Refrigerators and Freezers

Eligibility Criteria Draft 1 Version 5.0

Following is the **Draft 1 Version 5.0** product specification for ENERGY STAR residential qualified refrigerators and freezers. A product shall meet all of the identified criteria to earn the ENERGY STAR.

Note: This Draft 1 Version 5.0 specification contains EPA's proposed revisions for residential refrigerators and freezers. In July 2011 the Agency shared a Framework document that outlined EPA's reassessment of the current ENERGY STAR refrigerator and freezer requirements and facilitated discussion of this assessment and possible resulting modifications to these ENERGY STAR requirements. The Agency appreciates stakeholder feedback which has helped shape this Draft 1.

Please send comments via email to appliances@energystar.gov no later than December 9, 2011.

1) **Definitions:** Below are the definitions of the relevant terms in this document.

- A. **Electric Refrigerator:** A cabinet designed for the refrigerated storage of food, designed to be capable of achieving storage temperatures above 32°F (0°C) and below 39°F (3.9°C), and having a source of refrigeration requiring single phase, alternating current electric energy input only. An electric refrigerator may include a compartment for the freezing and storage of food at temperatures below 32°F (0°C), but does not provide a separate low temperature compartment designed for the freezing and storage of food at temperatures below 8°F (-13.3°C).
- B. **Freezer:** A cabinet designed as a unit for the freezing and storage of food at temperatures of 0 °F (-17.8°C) or below, and having a source of refrigeration requiring single phase, alternating current electric energy input only.
- C. **Electric Refrigerator-Freezer:** A cabinet which consists of two or more compartments with at least one of the compartments designed for the refrigerated storage of food at temperatures above 32 °F (0°C) and below 39°F (3.9°C), and with at least one of the compartments designed for the freezing and storage of food at temperatures below 8 °F (-13.3°C) which may be adjusted by the user to a temperature of 0 °F (-17.8°C) or below. The source of refrigeration requires single phase, alternating current electric energy input only.
- D. **Adjusted Volume (AV):** The sum of the fresh food compartment volume in cubic feet, and the product of an adjustment factor and the net freezer compartment volume.
- E. **Compact refrigerator/refrigerator-freezer/freezer:** Any refrigerator, refrigerator-freezer or freezer with total volume less than 7.75 cubic feet (220 liters)(rated volume as determined in Appendix A1 and B1 of 10 CFR § 430 subpart B) and 36 inches (0.91 meters) or less in height.
- F. **Basic Model:** All units of a given type of product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water

50 consumption, or water efficiency.

- 51 G. System Operator: The local distribution operator or other entity that is responsible for the issuance of
52 signals that request immediate or scheduled reduction of residential load from connected appliances.
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54 **Note:** Consistent with recent revisions to other appliance specifications, EPA has harmonized ENERGY STAR
55 definitions with the current DOE definitions in 10 CFR § 430.2. To this end, minor changes have been made to
56 the definitions of Electric Refrigerator (formerly Residential Electric Refrigerator), Electric Refrigerator-Freezer
57 (formerly Residential Refrigerator-Freezer), and Compact refrigerator/refrigerator-freezer/freezer (formerly
58 Compact).

59 On March 7, 2011, DOE clarified its interpretation of the Basic Model definition (Federal Register Vol. 76, No. 44,
60 page 12429). To harmonize, EPA has amended the above definition for Basic Model to be consistent with 10 CFR
61 § 430.2. For further explanation on the Basic Model definition, please refer to DOE's final rule.¹

62 EPA has proposed a new definition for System Operator to support EPA's proposal that products with demand
63 response (DR) and other communication capabilities be recognized as "Connected." After investigating existing
64 industry definitions for System Operator and consulting with the Electric Power Research Institute (EPRI), EPA
65 developed the above definition that is focused on applicability to residential appliances with demand response
66 (DR) capabilities.

67 EPA welcomes stakeholder comment on the proposed changes to the Section 1 definitions.

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69 **2) Scope:**

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71 A. Included Products: Products that meet the definition of an electric refrigerator, electric freezer, electric
72 refrigerator-freezer, and/or compact refrigerator/refrigerator-freezer/freezer, as specified herein and the
73 definition of a consumer product as specified in 10 CFR § 430.2 are eligible for ENERGY STAR
74 qualification.
75
76 B. Excluded Products: Commercial models, refrigerators and refrigerator-freezers with total refrigerated
77 volume exceeding 39 cubic feet, and freezers with total refrigerated volume exceeding 30 cubic feet are
78 not eligible for ENERGY STAR. Products that are covered under other ENERGY STAR product
79 specifications (e.g. Commercial Refrigerators) are not eligible for qualification under this specification.
80 Wine refrigerators are not eligible for qualification under this specification.

¹ DOE Final Rule available: http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/cce_finalrule_notice.pdf

Note: To help distinguish the residential refrigerator and freezer program from the ENERGY STAR commercial refrigerator program, EPA is proposing to specify in Section 2A that products must be a consumer product, as defined by DOE in 10 CFR § 430.2.

In the July 2011 Framework Document, EPA sought feedback on further possible clarifications to the scope of the program and the possibility of extending the ENERGY STAR label to cover certain refrigerator types including beverage centers, wine refrigerators, and beer refrigerators. After considering feedback received, EPA is proposing new language in Section 2B that would formalize EPA’s current policy of not covering wine refrigerators in the ENERGY STAR residential refrigeration program.¹ Several stakeholders expressed there was opportunity for additional savings from enabling these products to be eligible for ENERGY STAR. EPA plans to track DOE’s future rulemaking for wine storage and related products and will further engage with stakeholders to assess the savings opportunity from expanding the ENERGY STAR program to cover these products.

In addition, with the aim of further clarifying the scope of the program, EPA believes that all products meeting the technical definition of compact refrigerator or compact refrigerator-freezer – including, for example, compact refrigerators marketed as “beverage centers” – should be eligible to earn the ENERGY STAR. Therefore, EPA has not excluded these products in Section 2B.

EPA welcomes feedback on the proposed clarifications to the scope.

¹ See ENERGY STAR FAQ “Can a wine refrigerator, kegerator, or residential beverage chiller qualify for ENERGY STAR?” here: <http://energystar.supportportal.com/ics/support/default.asp?deptID=23018&task=knowledge&questionID=14503>

3) Qualification Criteria:

A. Energy Use Requirements

- a. Annual Energy Consumption (AEC) shall be less than or equal to Maximum Annual Energy Consumption (AEC_{MAX}), as calculated per Equation 1.

Equation 1. Calculation of Maximum Annual Energy Consumption Requirement

$$AEC_{MAX} = AEC_{BASE} + \sum_{i=1}^n AEC_{ADD_i}$$

where,

AEC_{BASE} is the annual energy consumption base allowance, per Table 1; and

AEC_{ADD_i} is an annual energy functional adder, per Table 2

Table 1: Annual Energy Consumption Base Allowances

Product Type	Annual Energy Consumption Base Allowance, AEC _{BASE} (kWh/year)
Full-Size Refrigerators and Refrigerator-freezers	
<ul style="list-style-type: none"> • Refrigerators and Refrigerator-freezers with manual defrost • Refrigerator-freezers with partial automatic defrost • Refrigerator-freezers with automatic defrost and top-mounted freezer • All Refrigerators with automatic defrost 	250 x tanh(0.050 x AV - 0.1) + 175

• Refrigerator-freezers with side-mounted freezer	$235 \times \tanh(0.050 \times AV - 0.1) + 270$
• Refrigerator-freezers with bottom-mounted freezer	$255 \times \tanh(0.045 \times AV) + 230$
Compact Refrigerators and Refrigerator-Freezers	
• Compact refrigerators and refrigerator-freezers	$255 \times \tanh(0.045 \times AV) + 230$
Full-Size and Compact Freezers	
• Compact and Full-Size Upright freezers with manual defrost	$330 \times \tanh(0.025 \times AV) + 198$
• Compact and Full-Size Upright freezers with automatic defrost	$430 \times \tanh(0.025 \times AV) + 284$
• Compact and Full-Size Chest freezers	$380 \times \tanh(0.025 \times AV) + 115$

Table 2: Annual Energy Functional Adders

Product Type	Description	Annual Energy Consumption Allowance, AEC_{ADD_i} (kWh/year)
<ul style="list-style-type: none"> • Refrigerator-freezers with top-mounted freezer • Refrigerator-freezers with bottom-mounted freezer • Refrigerator-freezers with side-mounted freezer 	Through-the-Door Ice Service	30
All product types in Table 1 ¹	Connected	$0.05 \times AEC_{BASE}$

¹Product must be qualified using the final and validated “connected” test procedure to use the allowance.

119 **Note:** In the July 2011 Framework document and webinar, EPA shared with stakeholders initial thoughts on
120 possible changes to the maximum annual energy use criteria for refrigerators and freezers for the Version 5.0
121 revision. In the Framework document EPA discussed a possible new approach that would better enable
122 consumers to identify the most energy-efficient refrigerators irrespective of configuration. Based upon
123 stakeholder feedback received following the Framework and further analysis of refrigerator performance data,
124 EPA is proposing new requirements in Section 3A.¹

125 For Version 5.0, EPA is proposing to maintain separate levels for refrigerators and refrigerator-freezers based on
126 different configurations: top freezers, side-by-sides, and bottom-freezers. However, in developing the Draft 1
127 levels, EPA's aim has been to significantly narrow the difference in energy-use among qualified models. To this
128 end, EPA is proposing more challenging levels for the most energy consumptive configurations. This approach
129 enables EPA to better distinguish top-performing models while providing consumers with choice among different
130 configurations and feature sets. Under the proposed requirements in 3A, refrigerators would need to have an
131 annual energy consumption of less than 500 kWh/year. The requirements would be modestly higher for models
132 that provide added functionality, such as through the door ice and/or connectivity. Currently, the average energy
133 consumption of full-size refrigerators and refrigerator-freezers meeting the proposed requirements is 397
134 kWh/year, a 16% reduction from the energy consumption of models qualified to Version 4.1 (468 kWh/year).

135 As discussed in the Framework document, EPA believes there is a limit to how much energy use a refrigerator
136 can use and still be credibly designated as energy efficient and good for the environment. In Draft 1, EPA is
137 proposing levels that continue to allow all full-size refrigerators to be eligible to earn the ENERGY STAR but
138 become gradually more challenging for larger units, while also recognizing there is some additional energy
139 requirement as refrigerators become bigger. Larger products are still eligible to earn the ENERGY STAR as long
140 as they can meet requirements that are on par with those met by standard sizes. Under the current proposal,
141 there are refrigerator-freezers models up to 26.5 cubic-feet that could qualify.

142 After reviewing compact refrigerator and refrigerator-freezer data, EPA found that many compact refrigerators
143 with manual defrost (DOE product class 11) and compact refrigerators with automatic defrost (DOE product class
144 13), use similar amounts of energy. Therefore, EPA is proposing a single level for all compact refrigerators and
145 refrigerator-freezers, an approach that provides greater continuity with the full-size refrigerator-freezer levels (by
146 using the bottom-freezers' equation). The proposed level represents a very small change from the current V4.1
147 requirement for compact manual defrost products. Given the availability of compact refrigerators with auto defrost
148 that currently exceed the ENERGY STAR requirements, the proposed level recognizes the most efficient products
149 in this category and provides about a 15% reduction from the current Version 4.1 requirement.

150 In anticipation that more efficient products will be introduced as manufacturers transition their product lines to
151 meet the 2014 Federal standards, EPA is proposing strengthened levels for each of the three types of freezers
152 covered in the program. These include upright freezers with automatic defrost, upright freezers with manual
153 defrost, and chest freezers. Given the different applicability of these products, EPA retained separate product
154 classes for these three types of freezers. The levels are inclusive of both compact and full-size freezers. The
155 proposed levels represent a 13% reduction in energy use for an 18.5 cu-ft upright freezer and an 8% reduction in
156 energy use for a 15 cu-ft chest freezer, relative to the current Version 4.1 requirements.

157 To help illustrate the proposed levels for stakeholders, EPA has appended a series of figures at the end of this
158 document that illustrate the new levels relative to current refrigerator performance data. Consistent with the
159 principle of no sacrifice, EPA is expressing levels as curves which increase as a function of size. In Section 3A,
160 Equation 1 specifies the Maximum Annual Energy Consumption (AEC_{MAX}) to qualify for ENERGY STAR. Within
161 this equation, AEC_{MAX} is the sum of the product's Base Annual Energy Consumption (AEC_{BASE}) and the summation
162 of applicable functional adders. Table 1 contains the proposed Annual Energy Consumption Base Allowance
163 (AEC_{BASE}) for each product type. Table 2 contains the proposed energy functional adders (AEC_{ADD_i}). As
164 discussed in the Framework, EPA is proposing functional adders to account for the additional energy used to
165 provide consumers with through the door ice (TTD) service and an allowance for products that meet the optional
166 "Connected" criteria in Section 4. EPA is proposing a 30 kWh/year allowance for TTD which accommodates the
167 best performing TTD models in all configurations. Products that meet the "Connected" criteria (proposed and
168 discussed further, in Section 4 of this document) and qualified using the final and validated DOE test method
169 (currently under development), could also utilize an allowance that is 5 percent of the product's base annual
170 energy consumption. EPA intends this allowance to serve as an incentive to help jump start the market for
171 connected appliances, provide immediate convenience and energy-savings opportunities as well as future-
172 oriented DR capabilities. As an example of how this allowance would work, under the proposed Version 5.0
173 levels, a typical 21 cu-ft bottom-mount with TTD would need to use less than 462 kWh per year (432 kWh + 30
174 kWh allowance for TTD) to qualify. If that product is qualified as meeting the "Connected" criteria, it could
175 consume up to an additional 22 kWh. In total this model's energy consumption with this allowance (484 kWh)
176 would be 27% less than a model that just meets the Federal standard (approx. 659 kWh per year).

177 EPA assessed product availability within different configurations and feature sets, looking at pass rates. The pass
178 rate is defined as the percentage of models that could qualify relative to the entire market or some sub-class of
179 the market, as represented by the ENERGY STAR data set. EPA estimates the current overall pass rate for full-
180 size refrigerators and refrigerator freezers is 11% and the pass rate among all full-size refrigerator and
181 refrigerator-freezer models with through the door ice (TTD) is 10%. Pass rates for different freezer configurations
182 are: top-freezers (15%); bottom-freezers (8%) and side-by-sides (9%). Currently, there are full-size products
183 available offered by a variety of different manufacturers that meet the proposed requirements.

184 EPA anticipates the refrigerator pass rate will increase by the time Version 5.0 comes into effect in early 2013,
185 providing consumers with even more choice in the marketplace. This is based on the Agency's assessment that
186 a number of additional models could be eligible after relatively modest efficiency improvements and thus
187 manufacturers may elect to adopt minor efficiency upgrades in current models and re-rate, to meet the proposed
188 levels. In addition, EPA anticipates that a number of new models, introduced by manufacturers in 2012 and 2013,
189 are likely to meet the proposed levels. For reference, 23% of 282 refrigerator models qualified so far in 2011
190 would meet the proposed levels. Based on current retail price data collected, EPA believes there will be cost
191 effective options at these levels available to consumers in all configurations.

192 About 20% of current compact refrigerators models would qualify, including both manual defrost products (DOE
193 product class 11) and automatic defrost products (DOE product class 13), offered by a number of different
194 manufacturers under a variety of brands. Based on EPA's data set, there are no products with partial automatic
195 defrost (DOE product class 12) that meet the proposed requirements. EPA has found these products' V4.1
196 requirements allow them to use significantly more energy than many other similar-sized products, including
197 models with automatic defrost. According to the Association for Home Appliance Manufacturers (AHAM) HRF 1-
198 2008 standard, products with partial automatic defrost have a system where freezer surfaces are defrosted
199 manually while refrigerator surfaces are defrosted automatically. EPA is seeking further information on this
200 product type including information on the energy-use associated with this type of defrost and the value it offers to
201 consumers.

202 Approximately 11% of all full-size and compact freezers meet the proposed requirements. EPA notes the pass
203 rate for full-size chest freezers is quite low; EPA is aware of virtually no product on the market that exceeds the
204 current ENERGY STAR V4.1 requirement. However, the DOE 2011 refrigerator and freezer Technical Support
205 Document analysis suggests that higher efficiency levels (>15% less energy than the current Federal standard),
206 both for full-size upright and chest freezers, are cost effective with a payback of less than 5 years. EPA believes
207 it is reasonable that manufacturers would be able to adopt modest efficiency improvements by 2013 to meet the
208 proposed levels.

209 ¹For its analysis, EPA is using a data set that consistent of current ENERGY STAR qualified models, supplemented with 2010
210 Federal Trade Commission (FTC) refrigerator model data. EPA has shared this dataset with stakeholders by posting an excel
211 data file to the ENERGY STAR website.

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213 B. Determination of Adjusted Volume: Adjusted Volume (AV) shall be calculated using the following:

214 Refrigerator Adjusted Volume = Fresh Volume + (1.63 x Freezer Volume)

215 Freezer Adjusted Volume = 1.73 x Freezer Volume

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217 C. Significant Digits and Rounding:

218 a. All calculations shall be carried out with directly measured (unrounded) values.

219 b. Unless otherwise specified, compliance with specification limits shall be evaluated using directly
220 measured or calculated values without any benefit from rounding.

221 c. Directly measured or calculated values that are submitted for reporting on the ENERGY STAR
222 website shall be rounded to the nearest significant digit as expressed in the corresponding
223 specification limit.

224
225 D. Model Numbers: Model numbers used for ENERGY STAR qualified product submissions shall be
226 consistent with Federal Trade Commission (FTC) and Department of Energy (DOE) submissions.

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232 **Note:** Consistent with other appliance specification revisions, EPA is proposing to revise the model number
233 language to clarify that model numbers used for ENERGY STAR qualified product submissions should be
234 equivalent to those used in compliance reports submitted to FTC and DOE. Currently in Version 4.1, EPA
235 requires that model numbers used follow FTC and DOE guidelines. EPA welcomes feedback on this proposed
236 change.

238 **4) “Connected” Product Criteria:**

239 To be eligible for the “Connected” allowance, a refrigerator, refrigerator-freezer, or freezer shall have the
240 following capabilities. The product must continue to comply with the applicable product safety standards – the
241 addition of the functionality described below shall not override existing safety protections and functions. Any
242 reduction in load cannot adversely impact the product’s operation, e.g., food preservation.

243 **Note:** Consistent with the principle of enhanced consumer value and in response to the petition EPA received
244 from a joint coalition of industry and efficiency advocates in early 2011, EPA has continued to evaluate how best
245 to address and encourage smart grid functionality in ENERGY STAR specifications. EPA appreciates all the
246 feedback it has received since releasing the July 2011 Framework document. In that document, EPA laid out
247 several possible approaches for advancing smart grid and ideas on defining smart grid functionality for
248 refrigerators and freezers in a way that is consistent with the principles of the ENERGY STAR program. Through
249 written comments and in-person meetings since July, stakeholders have made significant contributions in helping
250 to shape this Draft 1 proposal. EPA appreciates stakeholders’ involvement and input.

251 This Draft 1 reflects EPA’s intention to leverage the two complementary options discussed in the Framework.
252 Products meeting the proposed criteria in Section 4 would be eligible to earn an allowance, as discussed earlier in
253 this document. This allowance is intended to serve as an incentive to help jump start the market for refrigerators
254 and freezers with smart grid functionality, in recognition of the broader electric power system gains and the
255 consumer value proposition associated with a connected appliance that can interface with an energy
256 management system. This allowance is also intended to ensure products that are eligible for this credit deliver
257 immediate value to consumers through connected functionality such as alerts. In addition, EPA plans to highlight
258 products with this functionality, on the ENERGY STAR Qualified Product List (QPL), so that consumers, rebate
259 programs and other interested stakeholders can better identify and advance these products into the market.

260 EPA is proposing to refer to this bundle of demand response (DR) functionality and consumer-oriented
261 enhancements, as “Connected.” EPA feels this better reflects the current scope of the proposed criteria in
262 Section 4 and will facilitate better consumer understanding of the near term value while supporting infrastructure
263 that provides consumers the option of leveraging their product’s DR capabilities to save money on their energy bill
264 is built.

265 A. Home Energy Management (HEM) Functionality:

266 A “Connected” refrigerator, refrigerator-freezer, or freezer shall have the following capabilities:

- 267
- 268 1. *Energy Consumption Reporting:* The product shall be capable of providing feedback on its energy
269 consumption to an energy management system or other consumer authorized device, service or
270 application via a communication link. Energy consumption data shall be reported by the product in
271 intervals of 15 minutes or less.
 - 272 2. *Remote Management:* The product shall be capable of receiving and responding to remote requests,
273 via a communication link, similar to consumer controllable functions on the product. The product is
274 not required to respond to remote requests that would compromise performance and/or product
275 safety as determined by the product manufacturer.
 - 276 3. *Operational Status & Alerts:* The product shall be capable of providing the following information to the
277 consumer either on the product or via a communication link:
 - 278 a. Demand Response (DR) status (e.g., normal operation, delay load, temporary load
279 reduction), and
 - 280 b. At least two types of alerts relevant to the energy consumption of the product. For example,
281 alerts for refrigerators, refrigerator-freezers and freezers, might address: door left open
282 notification, reminder to clean refrigerator coils, or report of energy consumption that is
283 outside the product’s normal range.
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285 **Note:** EPA is proposing a number of consumer-oriented features a “connected” appliance must have to be eligible
286 for the incentive. The criteria proposed in 4A have been developed with significant input from appliance industry
287 stakeholders. EPA believes these enhancements support an important opportunity to empower consumers with
288 new information and control of their appliances and energy costs. As part of a broader trend towards connected
289 homes, appliance manufacturers are introducing communicating refrigerators that provide new features and
290 services to consumers. EPA focused Section 4A upon a select bundle of features that can unlock new energy
291 savings opportunities as well as consumer convenience. The Agency’s intent is to recognize opportunities that
292 can provide consumers with immediate value.

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294 *Energy Consumption Reporting:* Appliances that monitor and report their energy consumption can enable
295 increased “energy awareness” in residences. When consumers are armed with this information they are
296 empowered to take steps to reduce their consumption. In a Cape Light Compact Pilot, customers in their
297 Residential Smart Energy Monitoring Pilot program received access to an online energy monitoring system. This
298 system monitored only whole-house consumption and provided an on-line dashboard that presented savings
299 information in kWh, dollars and CO₂ reduction. Despite monitoring only premises metering data, during the pilot
300 participants reduced their home’s energy consumption an average of 9.3%¹ The American Council for an Energy
301 Efficient Economy (ACEEE) 2010 report *Advanced Metering Initiatives and Residential Feedback Programs: A*
302 *Meta-Review of Electricity Savings Opportunities* surveys a variety of feedback initiatives that have reduce average
303 household savings by 4-12% depending upon the type of feedback, with greater savings attributed to feedback
304 that is real-time and down to an appliance level.

305
306 Energy data from an appliance that reports energy consumption is likely to be the most meaningful to consumers
307 when presented in concert with whole-house consumption and consumption from other principle residential loads
308 such as lighting, hot water heating, and central air conditioning, and when it can be used to generate new insights
309 and personalized tips on steps consumers could take to reduce energy consumption. For the purposes of this
310 specification, requiring that connected refrigerators report their energy consumption is essentially a small step
311 towards the goal of reduced energy consumption through increased energy awareness. Thus, EPA considered it
312 important to ensure that product energy consumption reporting be accomplished with minimal incremental cost.
313 Therefore EPA is proposing an energy reporting requirement that does not specify a minimum level of accuracy,
314 but does require in Section 4D that the accuracy be disclosed to third-party developers. Stakeholders have
315 indicated that estimation rather than measurement of energy consumption can provide reporting accuracy on the
316 order of ± 10%, at a nominal incremental cost.

317
318 *Remote Management:* EPA is specifying that connected refrigerators and freezers include remote management
319 capabilities similar to what is controllable on the appliance itself. For example, this could include vacation mode
320 and/or other energy savings settings. For refrigerators, a vacation mode may take action such as reducing the
321 frequency of defrosts and suspension of ice making. Consumer research has indicated that consumers have
322 interest in having the ability to control lighting, appliance and thermostats with computers or mobile phones (see
323 for example, Parks Associates 2010 Residential Energy Management Survey¹).

324
325 *Operational Status and Alerts:* EPA believes it is essential that consumers retain ultimate control over their
326 appliances’ operation. Connected appliances need to first provide consumers with information on the product’s
327 Demand Response (DR) status (either on the product itself or via some external device), so that consumers can
328 then make decisions on whether to over-ride a response (e.g., if ice making is needed immediately).

329
330 Section 4A also specifies that products provide consumers with at least two alerts relative to the energy
331 consumption of the product. The language provides several examples including a door left open alert. When
332 consumers are notified of a door that was accidentally left open, they could shut the door, or if away, make a call
333 or send a text message asking someone else to do it. The alert might also be designed to alert consumers (or
334 some third party, authorized by consumers to receive this information) that the energy consumption is outside of
335 the normal range. Depending upon the degree of sophistication associated with this alert system and the
336 arrangement in place, a service center may be able to make an initial assessment of the problem in advance and
337 come prepared with the necessary replacement component(s), providing the repair in just a single visit.

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339 EPA is interested in stakeholder feedback on the proposed consumer-oriented features.
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341 ¹ <http://greentechadvocates.com/2011/01/26/automation-is-appealing-to-consumers-research-firm-says/>
342 ² [http://www.capelightcompact.org/library/2010/08/3.31.10-Residential-Smart-Home-Energy-Monitoring-Final-Evaluation-](http://www.capelightcompact.org/library/2010/08/3.31.10-Residential-Smart-Home-Energy-Monitoring-Final-Evaluation-Report.pdf)
343 [Report.pdf](http://www.capelightcompact.org/library/2010/08/3.31.10-Residential-Smart-Home-Energy-Monitoring-Final-Evaluation-Report.pdf)

344 B. Embedded Delay Defrost Capability

345 A “Connected” refrigerator, refrigerator-freezer, or freezer shall have an embedded delay defrost capability
346 active by default, where the consumer can input or the product itself shall identify, the time of day, and the
347 product shall automatically move the defrost function outside of the 4-hour peak load period specified by the
348 local utility or the traditional peak period e.g., defined as 3pm to 7pm in most parts of the United States. The
349 product may provide the consumer with the option to modify the scheduling of this functionality in order to, for
350 example, respond to a short term request from the utility, or adjust to a utility service territory that peaks
351 during a different time period. In the event of a power outage of 24-hours or lesser duration, after power is
352 restored the product shall not require any interaction from the consumer to maintain this defrost deferral
353 feature with the same settings as prior to the power outage.

354 **Note:** Products with embedded delay defrost capability could automatically (communications not necessary)
355 avoid defrosting during traditional periods of peak energy consumption. This capability does not require
356 interconnection with the Smart Grid and thus can provide grid benefit as soon as these products are put into
357 service. EPA estimates that this function, deployed across 1 million refrigerators could reduce power during the
358 assumed peak period (3-7pm) by about 3.5 megawatts (MW) and would shift approximately 8.4 gigawatt-hours
359 (GWh) annually from peak to non-peak periods.

360 In order for the embedded delay defrost capability to operate as intended, the product must maintain time
361 correctly. In addition, to ensure the identified benefit is not sacrificed after a power outage, EPA is also specifying
362 that the product continue to deliver this function after a power outage of 24 hours or less, without any interaction
363 from the consumer. This duration of 24 hours is intended to capture the majority of outages, while allowing
364 stakeholders to comply without the use of batteries for time retention. The proposed language provides
365 manufacturers with flexibility in how they comply. For example, the refrigerator may be designed to maintain time
366 set by the installer or consumer or may have access to an external time signal. If and how the product responds
367 to daylight savings time would also be at the discretion of the manufacturer. EPA notes that this capability, while
368 included in this bundle of connected criteria, does not necessarily rely upon any communication link.

369 EPA welcomes any stakeholder feedback on Section 4B.

370 C. Demand Response (DR) Functionality:

371 A “Connected” refrigerator, freezer or refrigerator-freezer shall include the following capabilities for
372 responding to signals from a system operator requesting scheduled shifts in electrical consumption or
373 reductions in load:
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- 375
- 376 1. *Delay Appliance Load Capability:* The capability of the product to respond to a signal from a System
377 Operator requesting a delay of load for a time duration not exceeding 4 hours.
 - 378 a. Upon receipt of this signal, except as permitted below, the product shall:
 - 379 i. shift defrost cycles beyond the delay period, and
 - 380 ii. either shift ice maker cycles beyond the delay period or reduce average energy
381 consumption during the delay period by at least 13% relative to that consumed during
382 an average load over a 24-hour period as defined by the DOE test procedure (10
383 CFR Part 430 Subpart B, Appendix A1 and/or B1), and may shift this energy
384 consumption beyond the delay period.
 - 385 b. The product shall be able to respond to at least one Delay Appliance Load signal in a 24-hour
386 period.

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2. *Temporary Appliance Load Reduction Capability*: The capability of the product to respond to a signal from a System Operator requesting a reduced load period for a time duration not exceeding 10 minutes.
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- a. Upon receipt of this signal, except as permitted below, the product shall restrict its average energy consumption during the load reduction period to no more than 50 percent of that consumed during an average load over a 24-hour period as defined by the DOE test procedure (10 CFR Part 430 Subpart B, Appendix A1 and/or B1).
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- b. Exceptions – Under the following conditions, the product is not required to restrict its average energy consumption in response to a Temporary Appliance Load Reduction signal.
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- i. If the Temporary Appliance Load Reduction signal is received during a defrost cycle, that defrost cycle may finish. However, no additional defrost cycles shall occur during the time period.
- ii. If there is a consumer initiated function such as a door opening or ice/water dispensing during the load reduction period.
- 401
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- c. The product shall be able to respond to at least one Temporary Appliance Load Reduction signal in a 24-hour period.

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The consumer shall be allowed to override the product's response to the Delay Appliance Load and Temporary Appliance Load signals. In addition, the product may allow consumer-set time duration limits for the above capabilities. However, the product shall not be shipped with pre-set time duration limits that are less than those listed above.

408

409 **Note:** The language proposed in Section 4C specifies that connected appliances respond to DR signals
410 whenever possible but without impacting normal operation, as perceived by the consumer. For refrigerators and
411 freezers, food preservation is the fundamental delivered benefit that must not be impacted.

412

413 Once supporting infrastructure is in place, it is expected that consumers could opt to enroll in future appliance DR
414 programs that provide direct monetary benefits for enrollment and/or participation. In addition, the grid could
415 benefit from increased operating efficiency with those savings passed on to all consumers through lower rates.

416

417 Refrigerators and freezers with Delay Appliance Load (DAL) capability will be able to reduce their energy
418 consumption for a scheduled period of up to four-hours in response to a signal from a system operator. For
419 refrigerators and freezers, EPA anticipates this would entail energy use being shifted from a critical time period to
420 a non-critical time of the day (other products, such as lighting, are able to shed load without shifting it to another
421 time of the day). To do this, products would avoid defrosting during the scheduled delay period. They would also
422 need to curtail energy use by delaying ice making cycles or through another means that achieves at least a 13%
423 reduction in energy use (e.g., small temporary changes to compartment temperature(s)). EPA is interested in
424 feedback from industry on other approaches they may consider to achieve the 13% reduction.

425

426 Products with a Temporary Appliance Load Reduction (TALR) capability will be able to make a deeper reduction
427 in energy (50%), for a shorter period of time (at least 10 minutes). The idea behind TALR is that an appliance
428 could be called upon to provide an immediate load reduction, helping grid operators to manage demand. A
429 collection of responsive end loads could be called upon to provide "spinning reserves," as an alternative to
430 ramping generators up and down to provide this service. Research (e.g., see PNNL 2010 *Use of Residential
431 Smart Appliances for Peak-Load Shifting and Spinning Reserves: Cost/Benefit Analysis*) has suggested
432 appliances can be support more reliable power system operation, especially as the penetration of renewable
433 energy sources increases.

434

435 For testing purposes (discussed later in Section 5), both DAL and TALR energy use reductions are to be
436 measured against the DOE test procedure for refrigerators (Appendix A1) and freezers (Appendix B1). The
437 proposed language for these two DR capabilities builds directly upon the definitions recommended to EPA by a

438 joint coalition of stakeholders. EPA notes that through ongoing discussions with stakeholders, there have been
439 several changes and clarifications made to this original definition, including:

440 1) For the DAL capability, the proposed alternate response to delay of ice-making has been changed from a
441 fixed wattage to a percentage of the product's measured baseline consumption (measured in the DOE test
442 procedure). This change enables products with different baseline consumptions to be treated in a more equitable
443 manner.

444 2) Stakeholders have suggested several special cases (i.e., exemptions) for this DAL capability. Namely, if a
445 signal is received while a product is making ice or defrosting, it was suggested that that function should finish and
446 not occur again during the delay period, but no further reduction in energy use should be required. EPA has not
447 included this language since the language provides manufacturers with options on how to reduce energy use
448 (e.g., delay ice maker cycles or by some other means that reduces energy use by 13%). For this reason,
449 exemptions singling out several possible responses could be problematic. EPA is interested in feedback from
450 stakeholders on any scenarios where a product would not be able to meet the 13% load reduction while still
451 delivering on performance and consumer expectations, and how those cases should be treated within the
452 proposed DAL capability.

453
454 In contrast, for TALR capability, EPA has specified, based upon the petition's recommendation, that products not
455 be required to respond to a TALR request if there is a consumer-initiated function (e.g., door opening) during the
456 load reduction period. EPA believes this helps protect against possible negative consumer experiences that
457 could result from a sudden loss of functionality. (However, it should be noted that consumer-initiated functions
458 such as door openings, are not part of the current DOE test procedures). Also, the language in Section 2b
459 specifies that if the signal is received during a defrost cycle, that cycle may finish, and the product would not be
460 required to respond to the TALR request. Given the energy-intensity of defrost, EPA believes it would likely be
461 difficult for a product to achieve a 50% energy reduction over a 10 minute period, if it is defrosting during some or
462 all of that time, but is interested in further information on this.

463
464 EPA welcomes stakeholder comments on these proposed revisions.
465

466 D. Communication Standards, Open Access & Information to Consumers

467 A "Connected" refrigerator, refrigerator-freezer, or freezer shall meet all of the following criteria:

- 468 1. *DR Communication Standards*: For functionality specified in Section C, the product shall use Home
469 Area Network (HAN) standards identified by the National Institute of Standards and Technology
470 (NIST) Smart Grid Interoperability Panel.²
471
- 472 2. *HEM Communication Standards and Open Access*: For functionality specified in Section A,
473 documentation shall be made available to 3rd party developers regarding the accuracy of energy
474 consumption reporting and to allow transmission, reception and interpretation of the following
475 information:
 - 476 • Energy Consumption Reporting;
 - 477 • Remote Management
 - 478 • Operational Status & Alerts (if provided to consumers via a communication link)
479

2 http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PMO#Catalog_of_Standards_Processes

480 **Note:** For DR functionally, EPA is specifying that connected appliance communications use NIST Smart Grid
481 Interoperability Panel (SGIP) identified standards to help ensure robust security and interoperability. For HEM
482 communications, EPA's intent is to help drive open standards, interoperability, and 3rd party access, enabling
483 consumers to leverage innovation applications providing new energy management services. SGIP identified
484 standards may also be used for HEM communications, but use of other communication standards is also
485 permitted. While not mandated, EPA encourages the development of common appliance control command sets
486 and use open standards for HEM communications.

487 EPA is interested in stakeholder feedback on Section 4D. In particular, does the proposed language deliver on
488 the goals of encouraging open standards, interoperability and 3rd party access? Is there additional specificity
489 (either in this or future specification revisions) that EPA should consider to help drive enhanced interoperability for
490 HEM functionality?

- 491 3. *Information to Consumers:* If additional modules, devices and/or infrastructure are needed to activate
492 the product's communications capabilities specified in Sections A and C, prominent labels with
493 instructions shall be displayed at the point of purchase and in the product literature. These shall
494 provide specific information on what consumers must do to activate these capabilities (e.g. "*This
495 product requires installation of a network module compatible with the utility smart meter, energy
496 management gateway or other communication device for interconnection with the Smart Grid, Energy
497 Management System, and/or with other external devices, systems or applications.*").

498
499
500 If the product requires installation of one or more communication modules to enable communications
501 specified in A and C, these modules must be easily user installable and shall either ship with the
502 product or be provided to consumers by the manufacturer in a reasonable amount of time.
503

504 **Note:** So that consumers have the information needed to take full advantage of these connected functionalities,
505 Section 4D(3) specifies that information be provided by manufacturers on a product tag and in product literature,
506 informing consumers what additional modules, devices and/or infrastructure is necessary to activate the product's
507 communication capabilities. In addition, EPA has specified that if the product requires the installation of one or
508 more communication modules to deliver the functionality specified in 4A and 4C, that the module either ship with
509 the product or be provided to consumers in a reasonable amount of time, by the manufacturer. EPA has allowed
510 this second option, acknowledging the relevant HAN standards (e.g., Smart Energy Profile 2.0) are currently in
511 development and it may be advantageous for manufacturer to provide a mail-in form so consumers receive the
512 module, when available, at no additional cost. In addition, EPA specifies that these modules be easily installable
513 by a consumer.

514 **5) Test Requirements:**

- 515 A. One of the following sampling plans shall be used to test energy performance for qualification to
516 ENERGY STAR:
- 517 a. A representative unit shall be selected for testing based on the definition for Basic Model provided
518 in Section 1 above; or
- 519 b. Units shall be selected for testing per the sampling requirements defined in 10 CFR § 429.14.

Note: In response to stakeholder feedback and consistent with other appliance specification revision efforts, EPA has made explicit reference to the latest DOE sampling procedures (found in the March 7, 2011 Federal Register Vol. 76, No. 44, on page 12454) for purposes of qualification testing. This added language formalized the current practice, to allow manufacturers the option to demonstrate qualification based on a single test or leverage testing performance for purposes of minimum efficiency standards.

EPA has also clarified that the test requirements in 5A, are specific to testing a product's energy consumption.

- B. When testing energy consumption of residential refrigerators and freezers, the following test methods shall be used to determine ENERGY STAR qualification:

Table 3: Test Methods for ENERGY STAR Qualification

ENERGY STAR Requirement	Test Method Reference
Energy Consumption (kWh/year)	10 CFR 430, Subpart B
	Appendix A1 – Residential Refrigerators
	Appendix B1 – Residential Freezers

- C. When determining energy performance for purposes of ENERGY STAR certification, the principles of interpretation, contained in 10 CFR 430.23 (a) (10), should be applied to the test procedure.
- D. Compliance with Connected criteria, necessary to earn option designation of “Connected,” shall be verified as specified in Table 4.

Table 4: Methods of Compliance with Connected Product Criteria

Criteria	Method of Compliance
- DR Functionality	[ENERGY STAR test method for DR functionality in development]
- HEM Functionality - Embedded Delay Defrost Capability - Communication Standards, Open Access & Information to Consumers	Examination of product and/or product documentation

Note: DOE is developing a test procedure that will assess the DR capabilities (Section 4C) of refrigerators, refrigerator-freezers and freezers. This test is anticipated to be an add-on test procedure (i.e., performed in addition to the current A1 and B1 test procedures used for compliance with DOE standards and for determining energy consumption for purposes of ENERGY STAR qualification.) DOE will be sharing a status update and initial thoughts on this test procedure, during the upcoming ENERGY STAR webinar scheduled to discuss this Draft 1. Products will need to be qualified using the final and validated DOE test method (currently under development), in order to utilize the proposed 5 percent allowance.

EPA is proposing that models be certified to Connected criteria 4B, 4C, and 4D based upon examination of product and/or product documentation.

Both agencies welcome feedback on these proposals.

- 6) Effective Date:** The ENERGY STAR Residential Refrigerator and Freezer specification shall take effect on **January 1, 2013**. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on the model's date of manufacture. The date of manufacture is specific to each unit

551 and is the date (e.g., month and year) on which a unit is considered to be completely assembled.

552 **Note:** Under the anticipated schedule for the refrigerator specification revision, EPA expects to finalize the
553 Version 5.0 specification in March 2012, with an effective date of January 1, 2013. Manufacturers could elect
554 to have their products certified to the new specification as soon as it is finalized.

555 EPA welcomes stakeholder feedback on the proposed effective date.

- 556 **7) Future Specification Revisions:** EPA reserves the right to change the specification should technological
557 and/or market changes affect its usefulness to consumers, industry or the environment. In keeping with
558 current policy, revisions to the specification are arrived at through industry discussions. In the event of a
559 specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of
560 a product model.
561

562 **Note:**

563 *Possible proposal of Version 6.0 levels through this specification revision*

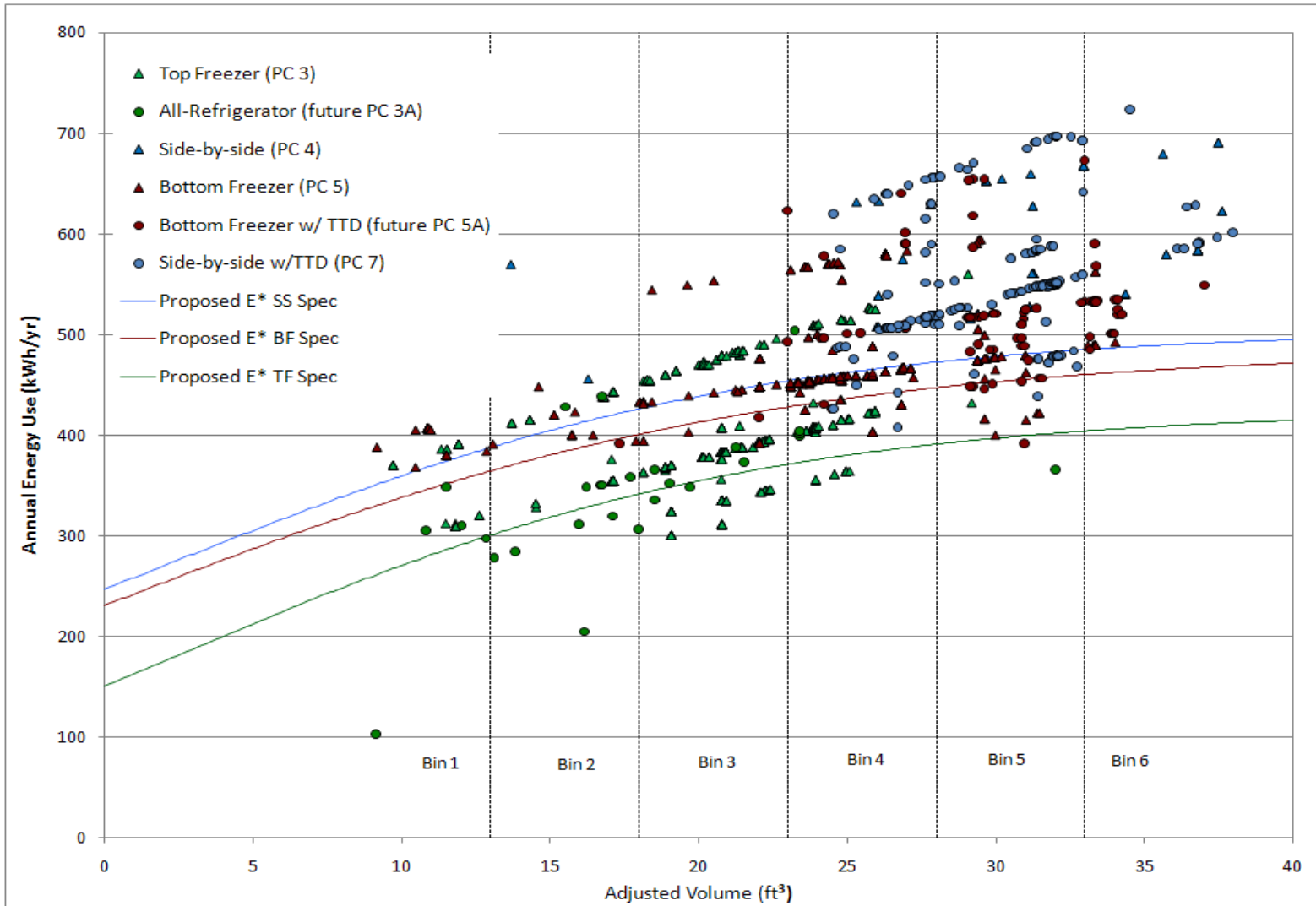
564
565 In September 2011, DOE published a Final Rule finalizing new standards for refrigerators, refrigerator-
566 freezers and freezers. Manufacturers are required to comply with these standards beginning September 15,
567 2014, and will be using a new test procedure to demonstrate compliance. In light of these new levels, EPA
568 believes the ENERGY STAR requirements will need to be strengthened at this time, to ensure the ENERGY
569 STAR label continues to be meaningful differentiation. In addition, to be consistent with the regulatory
570 schedule, EPA would likely specify that starting in 2014 products would need to be tested and certified to
571 ENERGY STAR based upon the new DOE test procedure. EPA believes it may be helpful for the Agency to
572 develop Version 6.0 levels through this current specification process, providing manufacturers with more
573 certainty during a time they are undergoing a significant re-design in preparation for the new standards.
574

575 In order to establish these Version 6.0 levels, EPA needs test data on refrigerator performance under the new
576 DOE test procedure (Appendix A for refrigerators, Appendix B for freezers). EPA is also discussing with DOE
577 how DOE's cross walk calculations might be leveraged to help identify appropriate out year ENERGY STAR
578 levels. EPA welcomes comments from stakeholders on the proposal to establish Version 6.0 requirements
579 during this stakeholder process. If this approach is used, EPA would build a dataset, including manufacturer
580 and other stakeholder data, which would be used to inform level setting.
581

582 *Low GWP foam-blowing agents*

583
584 Given the availability and low-cost of low GWP foam blowing agent alternatives, in the Framework document
585 EPA signaled that the Agency was considering a requirement that all ENERGY STAR refrigerators be
586 produced with a low GWP foam blowing agent. A number of stakeholders supported that requirement and
587 additional stakeholders indicated they would likely support as long as more time was provided by EPA to
588 comply with this types of requirement. Following the Framework, EPA also received information on new, low
589 GWP fluorinated alternatives that are in development and may provide improved energy efficiency
590 performance to the predominant hydrocarbon alternative, employed today. In response to the feedback and
591 in light of these developments, EPA has decided to defer consideration of this issue.
592

Figure 1. Proposed V5.0 Levels for Full-Size Refrigerators and Refrigerator-Freezers

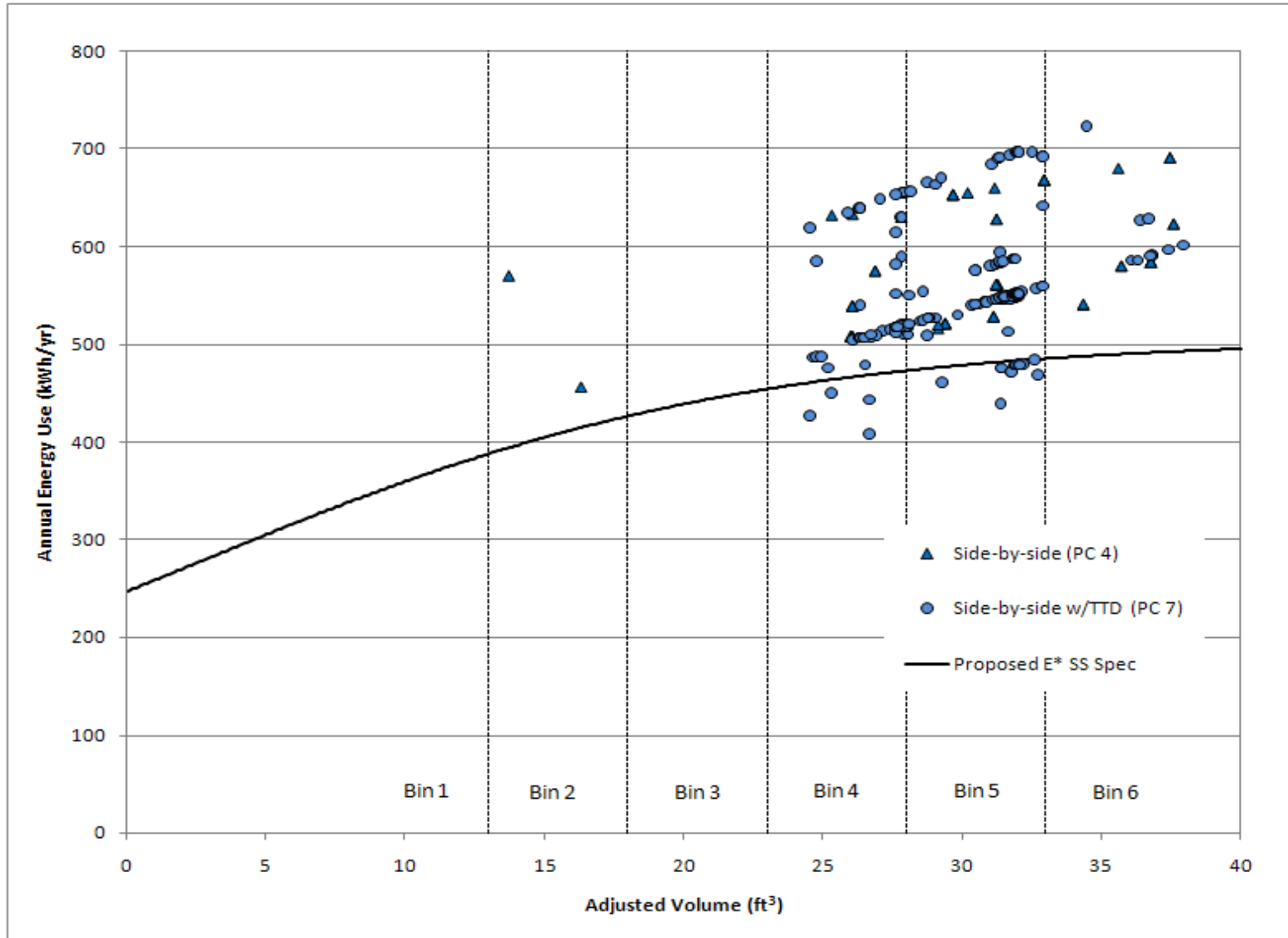


594

595 **Note:** Annual Energy Use of models with through the door ice service, have been adjusted by the amount of the proposed functional adder (30
596 kWh/year) in order to convey the models that meet the proposed levels.

597

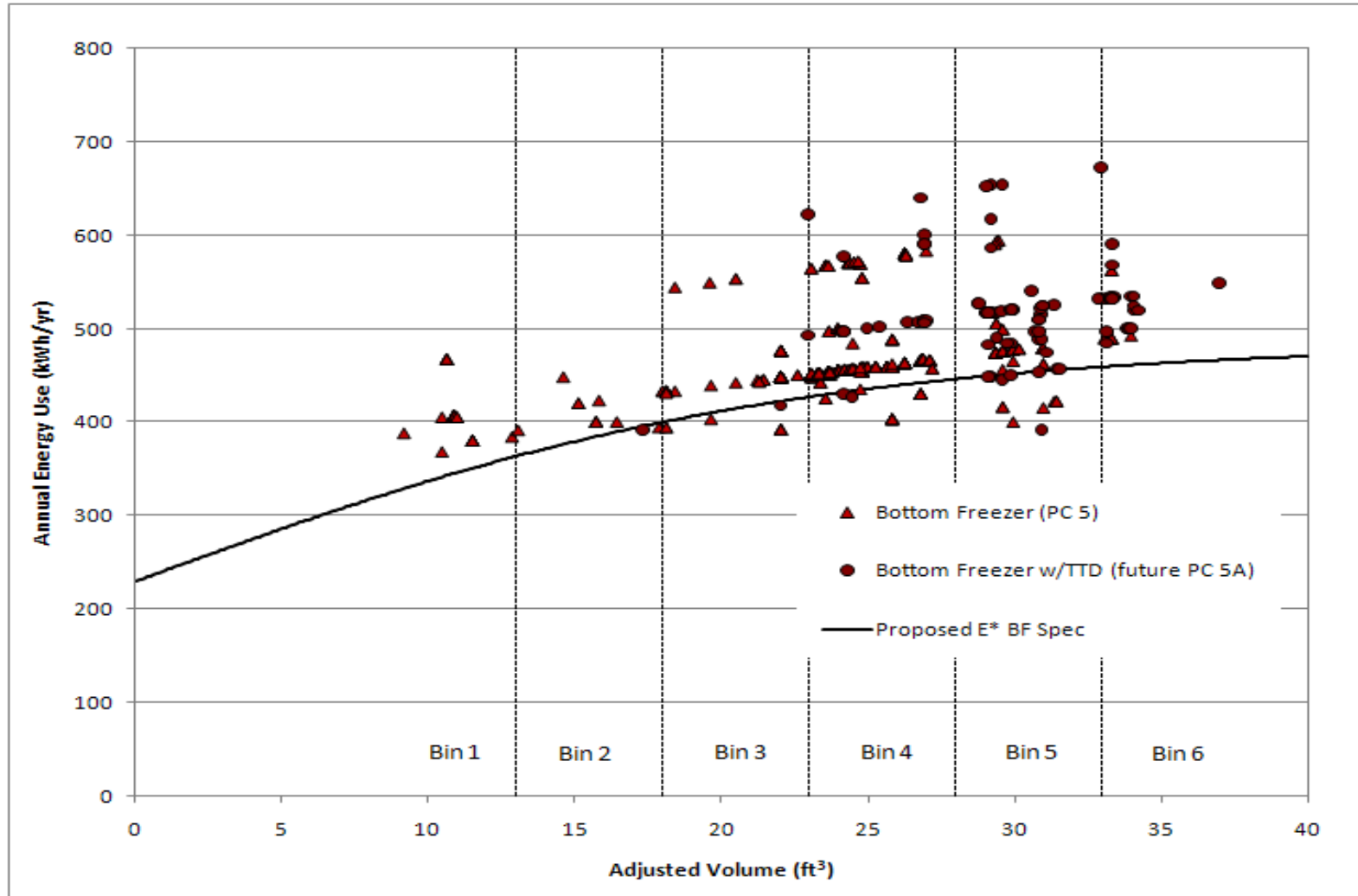
Figure 2. Proposed V5.0 Level for Side by Sides



600 **Note:** Annual Energy Use of models with through the door ice service, have been adjusted by the amount of the proposed functional adder (30
 601 kWh/year) in order to convey the models that meet the proposed levels

602

Figure 3. Proposed V5.0 Level for Bottom Freezers



603

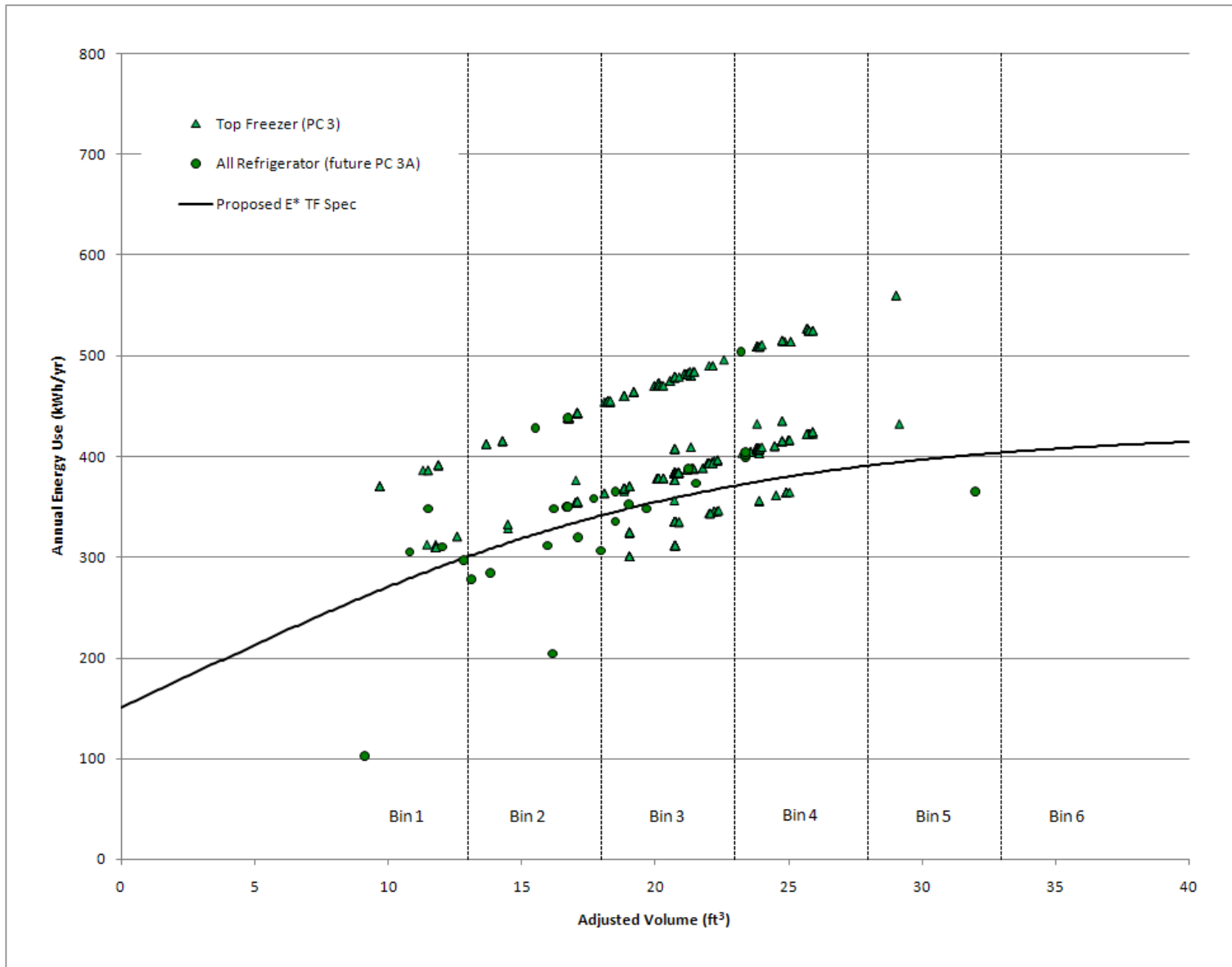
604 **Note:** Annual Energy Use of models with through the door ice service, have been adjusted by the amount of the proposed functional adder (30
605 kWh/year) in order to convey the models that meet the proposed levels

606

607

608

Figure 4 Proposed V5.0 Level for Top Freezers



611 **Note:** Annual Energy Use of models with through the door ice service, have been adjusted by the amount of the proposed functional adder (30
 612 kWh/year) in order to convey the models that meet the proposed levels
 ENERGY STAR Program Requirements for Residential Refrigerators and Freezers – Eligibility Criteria

Figure 5. Proposed V5.0 Level for Compact Refrigerators and Refrigerator-Freezers

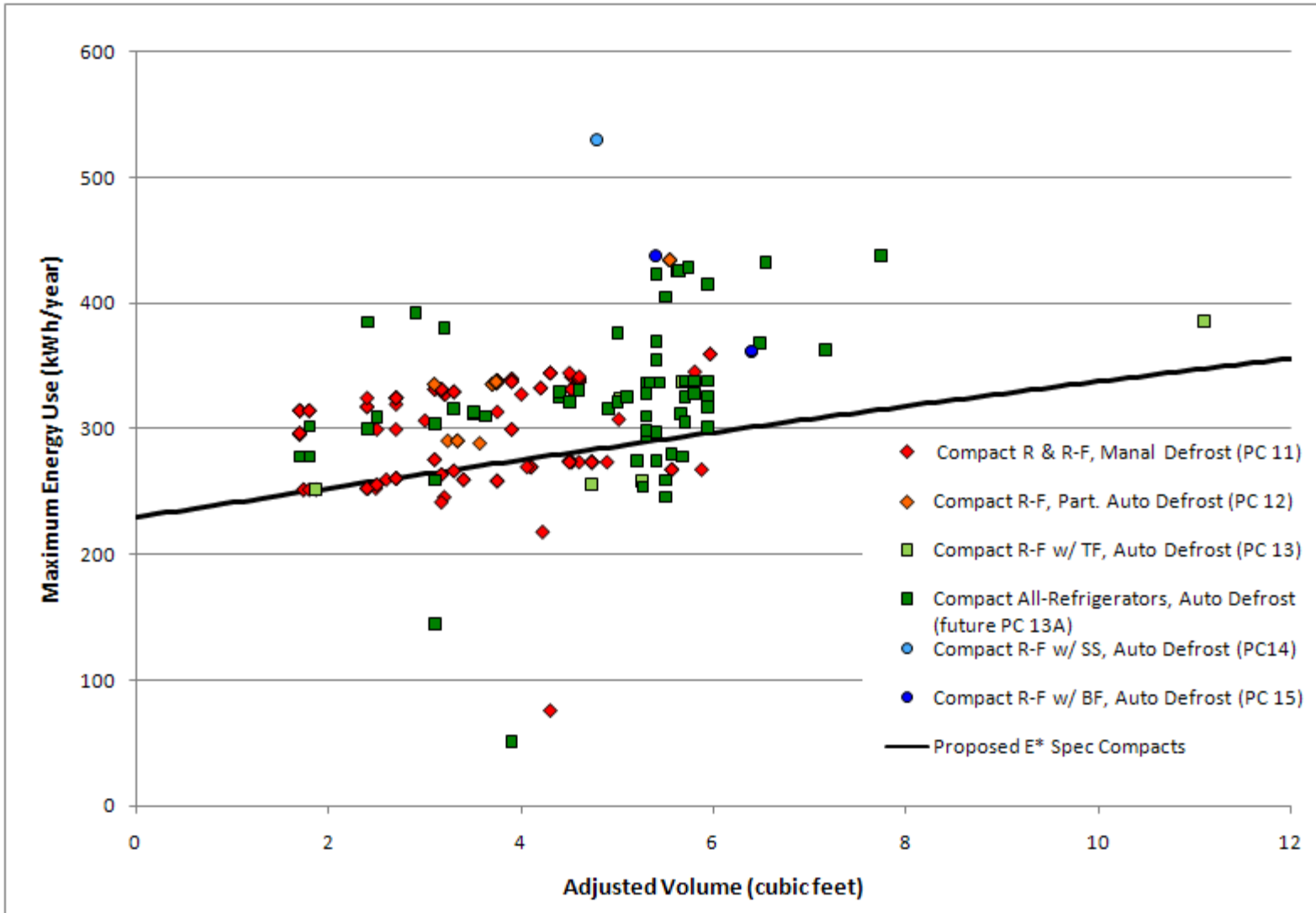


Figure 6. Proposed V5.0 Levels for Freezers

