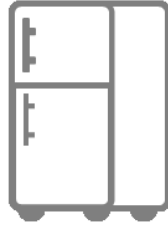
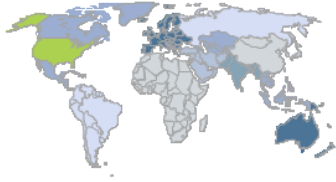
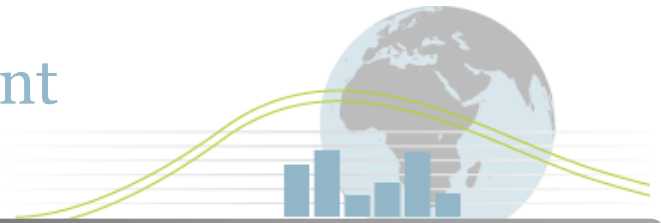


4E

Mapping Document



Country:	USA
Technology:	Domestic Cold Appliances
Sub Category:	Freezers and Refrigerator/ Freezers Combinations

Introduction

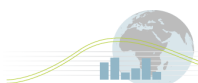
The first stage in the Mapping and Benchmarking process is the definition of the products, i.e. clearly setting the boundaries that define the products for use in data collection and analysis. Doing this ensures that comparison between the participating countries is done against a specific and consistent set of products.

The summary definition for this product is:

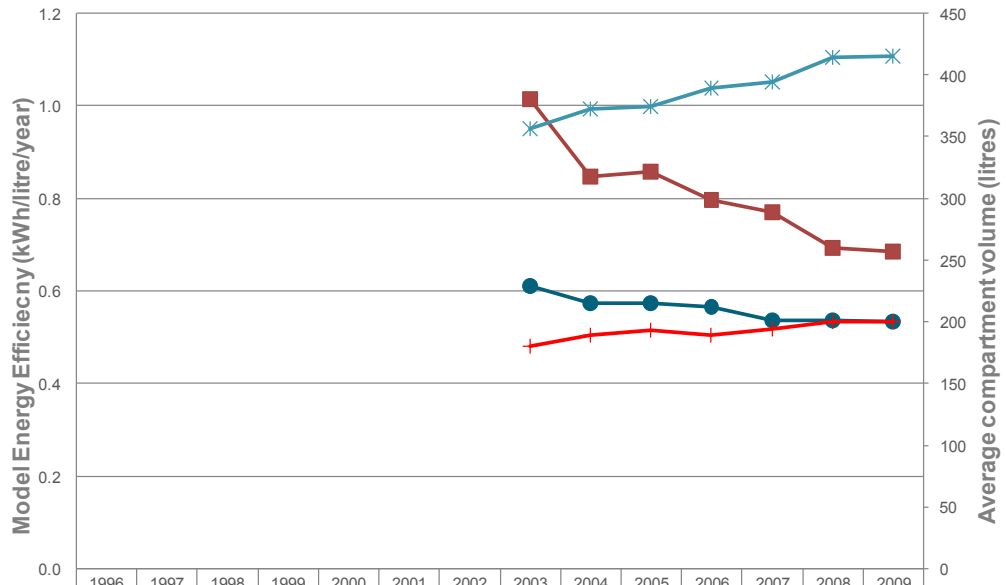
Under Counter/ upright Refrigerators (Single Grouping – collect data only)	Refrigerator with freezer (ice) compartment (Single grouping – collect data only)	Side-by-Side and Freezer top/ Refrigerator bottom and Refrigerator top/ Freezer bottom (Collect data on proportion of each type of unit in the market)	Chest/Under Counter/Upright Freezer (Collect data on proportion of each type of unit in the market)
Where units are:			
<ul style="list-style-type: none"> From all climate classes (but collect data on specific climate class that may be useful for later analysis) Have freezer compartments with rated temperatures below -12 (all temperature ratings to refrigerator with freezer (ice) compartment) Differentiated (if possible) between units with peripheral water coolers and ice makers 			
Do not differentiate between			
<ul style="list-style-type: none"> Defrost Cycles including Manual/Cyclical/Automatic (although collect data in case normalisation is required) Controls mechanisms including manual, automatic and cyclical Built in and stand-alone units (but where differentiated in market, collect data to enable normalisation) Volume (but collect data on gross volumes as base metric) Climate class (but collect data on climate class in case future analysis required, plus data on related local test conditions for climate classes) 			

The detailed product definitions can be found at the Annex website:

<http://mappingandbenchmarking.iea-4e.org/>



Energy Efficiency of New Fridge Freezers USA



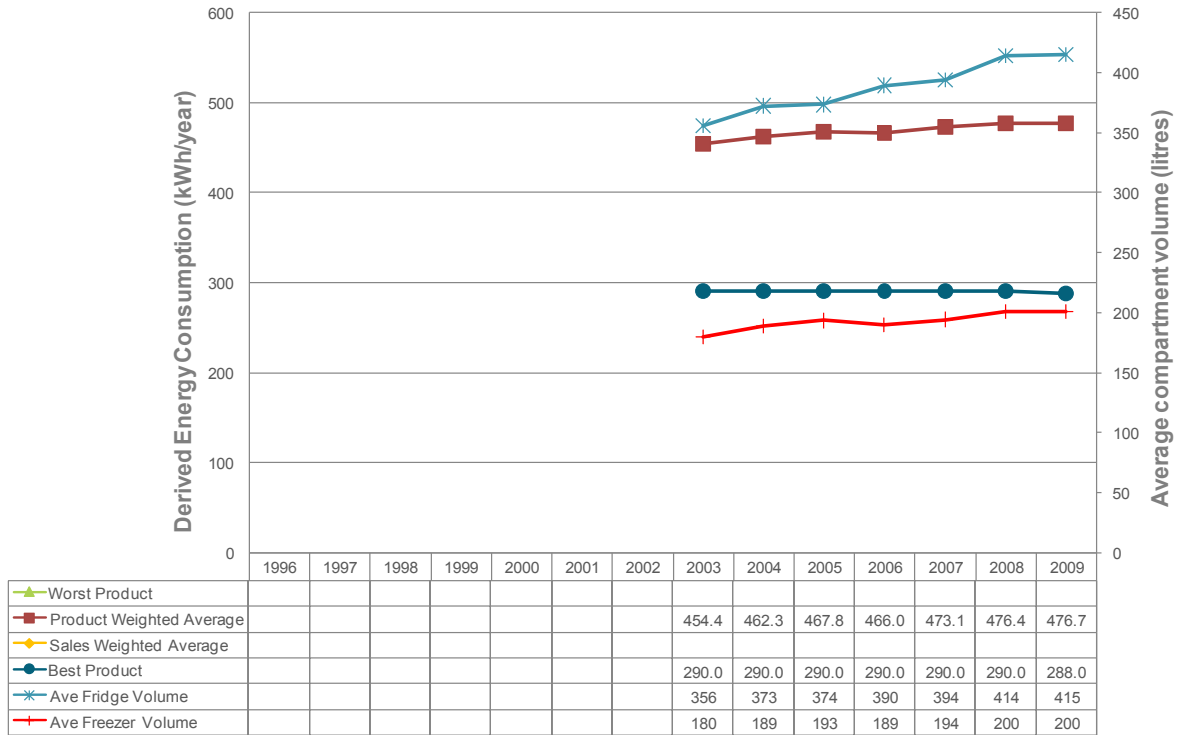
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Worst product														
Product Weighted Average								1.01	0.85	0.86	0.80	0.77	0.69	0.68
Sales Weighted Average														
Best Product								0.61	0.57	0.57	0.57	0.54	0.54	0.53
Ave Fridge Volume								356	373	374	390	394	414	415
Ave Freezer Volume								180	189	193	189	194	200	200

Key notes on Graph (see notes section 1)

- Data is from the ENERGY STAR¹ database of accredited products which does not cover the entire USA market as the scheme is voluntary, and is aimed to distinguish the best performing products. In particular, it would be misleading to indicate a product from this database as being the “worst” on the market and hence this aspect is not plotted on the graph above.
- The ENERGY STAR data set is maintained based on a “date of introduction” and “date of withdrawal” for individual models. Models are assumed to be available in the market for the full period between these dates.
- Only products classified as side-by-side, top freezer and bottom freezer in the ENERGY STAR database are assessed.
- Sales weighted average calculations were not possible (no sales data were available).
- Energy efficiency figures are based on performance under local test conditions and adjusted to account for two main differences in product technology/functionality:
 - adjusted fridge/freezer volume based on conversion factors used in the USA
 - whether the product has an ice making device

¹ For information on the Energy Star Programme for Refrigerators – see: http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators

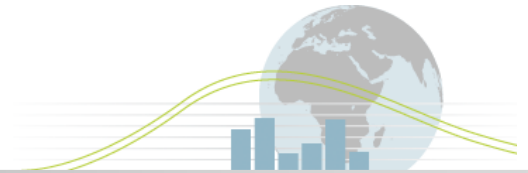
Energy Consumption of New Fridge Freezers USA



Key notes on Graph (See notes section 2)

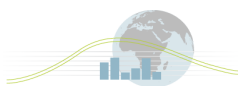
- Data is from the ENERGY STAR² database of accredited products which does not cover the entire USA market as the scheme is voluntary, and is aimed to distinguish the best performing products. In particular, it would be misleading to indicate a product from this database as being the “worst” on the market and hence this aspect is not plotted on the graph above.
- The ENERGY STAR data set is maintained based on a “date of introduction” and “date of withdrawal” for individual models. Models are assumed to be available in the market for the full period between these dates.
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 - adjusted fridge/freezer volume based on conversion factors used in the USA
 - whether the product has an ice making device

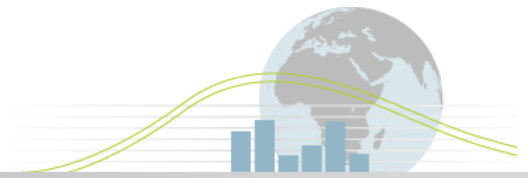
² For information on the Energy Star Programme for Refrigerators – see: http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators



Energy Efficiency in the Installed Fridge Freezer Stock USA

- Insufficient data available for analysis.



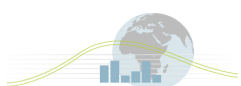


Energy Consumption in the Installed Fridge Freezer Stock USA

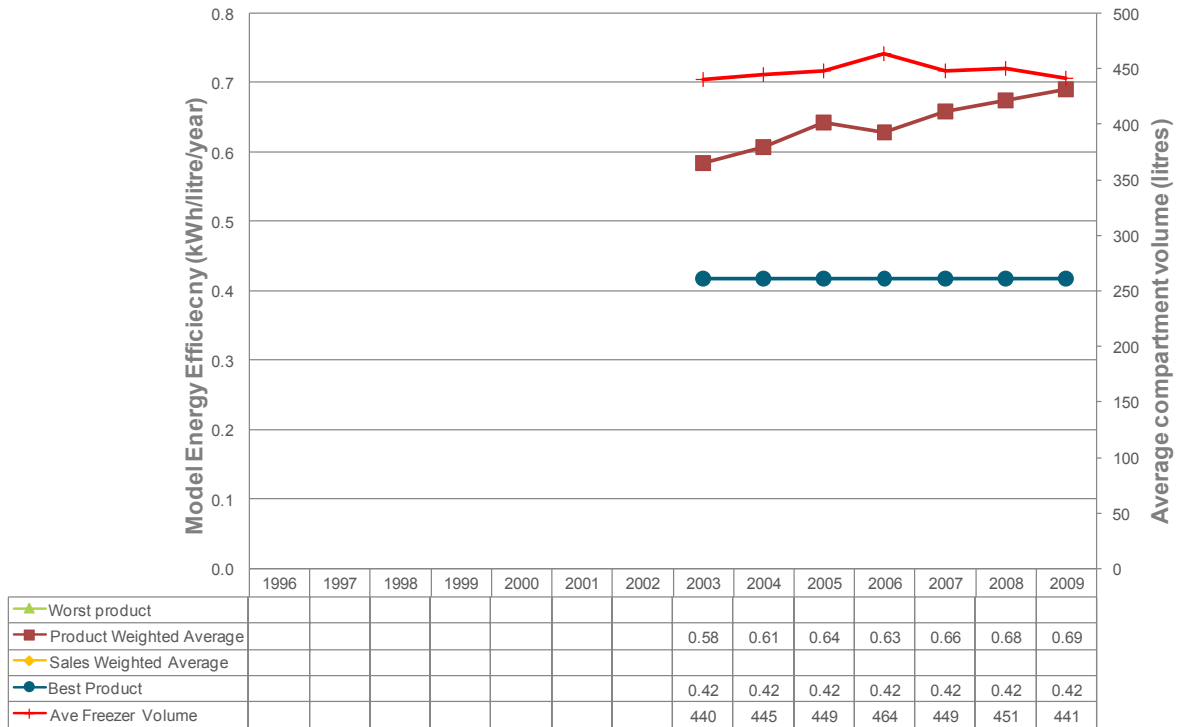


Key notes on Graph (see Notes Section 4)

- **THIS GRAPH SHOWS RESULTS FOR ALL DOMESTIC COLD APPLIANCES BECAUSE THE SURVEY DATA USED WAS NOT AVAILABLE FOR REFRIGERATOR FREEZERS SEPARATELY.**
- Graph is based on the Energy Information Administration’s Residential Energy Consumption Surveys rather than sales data.



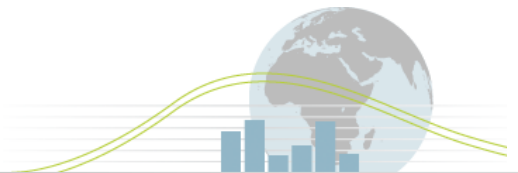
Energy Efficiency of New Freezers USA



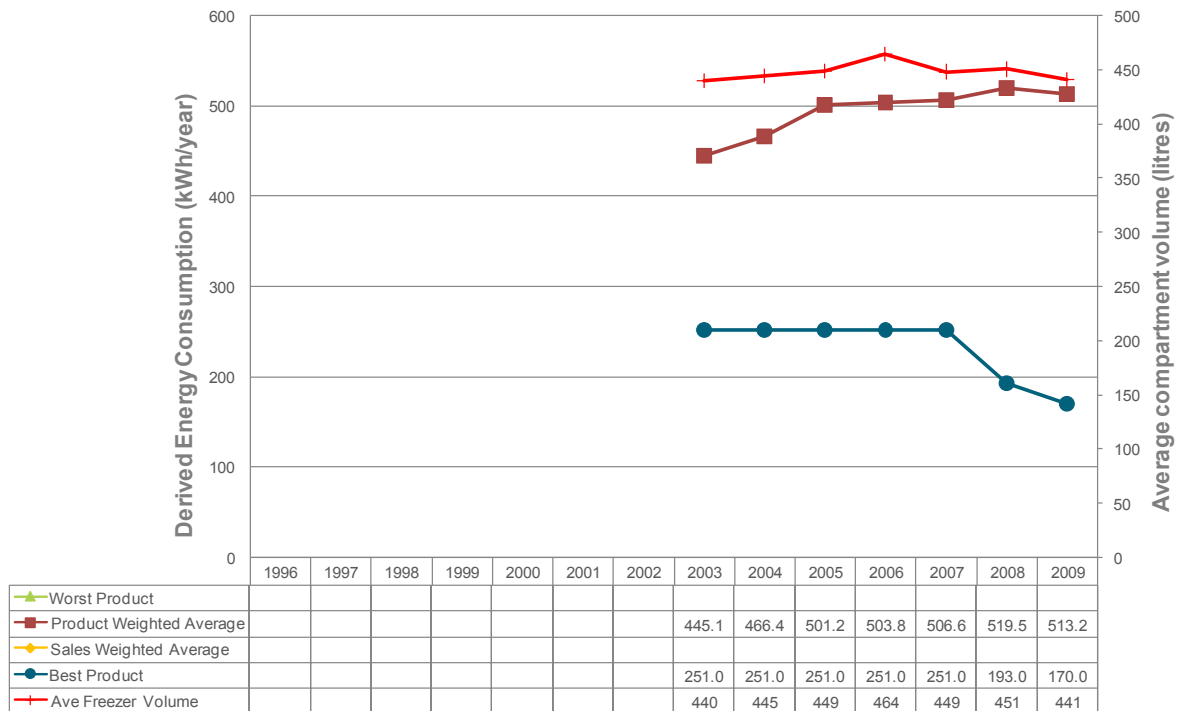
Key notes on Graph (see notes section 1)

- Data is from the ENERGY STAR³ database of accredited products which does not cover the entire USA market as the scheme is voluntary, and is aimed to distinguish the best performing products. In particular, it would be misleading to indicate a product from this database as being the “worst” on the market and hence this aspect is not plotted on the graph above.
- The ENERGY STAR data set is maintained based on a “date of introduction” and “date of withdrawal” for individual models. Models are assumed to be available in the market for the full period between these dates.
- Only products classified as upright and chest freezers in the ENERGY STAR database are assessed.
- Sales weighted average calculations were not possible (no sales data were available).
- Energy efficiency figures are based on performance under local test conditions and adjusted to account for two main differences in product technology/functionality:
 - adjusted fridge/freezer volume based on conversion factors used in the USA
 - whether the product has an ice making device

³ For information on the Energy Star Programme for Refrigerators – see: http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators



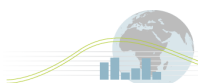
Energy Consumption of New Freezers USA

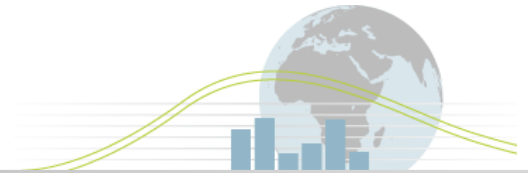


Key notes on Graph (See notes section 2)

- Data is from the ENERGY STAR⁴ database of accredited products which does not cover the entire USA market as the scheme is voluntary, and is aimed to distinguish the best performing products. In particular, it would be misleading to indicate a product from this database as being the “worst” on the market and hence this aspect is not plotted on the graph above.
- The ENERGY STAR data set is maintained based on a “date of introduction” and “date of withdrawal” for individual models. Models are assumed to be available in the market for the full period between these dates.
- Only products classified as upright and chest freezers in the ENERGY STAR database are assessed.
- Sales weighted average calculations were not possible (no sales data were available).
- Energy efficiency figures are based on performance under local test conditions and adjusted to account for two main differences in product technology/functionality:
 - adjusted fridge/freezer volume based on conversion factors used in the USA
 - whether the product has an ice making device

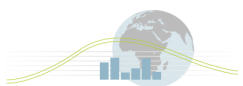
⁴ For information on the Energy Star Programme for Refrigerators – see: http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators

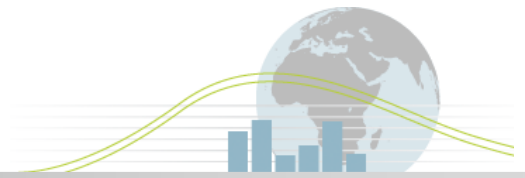




Energy Efficiency in the Installed Freezer Stock USA

- Insufficient data available for analysis.



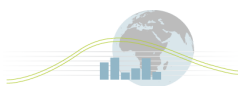


Energy Consumption of the Installed Freezer Stock USA



Key notes on Graph (see Notes Section 4)

- **THIS GRAPH SHOWS RESULTS FOR ALL DOMESTIC COLD APPLIANCES BECAUSE THE SURVEY DATA USED WAS NOT AVAILABLE FOR REFRIGERATOR FREEZERS SEPARATELY.**
- Graph is based on the Energy Information Administration's Residential Energy Consumption Surveys rather than sales data.



Major Policy Interventions (See notes Section 5)

The USA has three primary federal policy⁵ interventions related to refrigerators and freezers:

- **Minimum Energy Performance Standards:** Based on the 1987 National Appliance Energy Conservation Act, which gives the Department of Energy the ability to place minimum energy standards on products, and by the National Appliance Energy Conservation Amendments in 1998. The current standards for refrigerators are defined in: *"10 CFR Part 430: Energy Conservation Program for Consumer Products: Energy Conservation Standards for Refrigerator-Freezers"*.

MEPS for refrigerators and freezers were first introduced in 1990 with revisions in 1993 and 2001. The Department of Energy is considering strengthened standards with an announcement expected before the end of 2010 with an effective date 2014.

- **Mandatory Labelling:** EnergyGuide, which provides an indication of comparative energy consumption and an estimate of costs to the consumer. First introduced in 1980, with a redesigned label (featuring more prominently displayed costs estimates being announced in 2007)
- **Voluntary Labelling:** Energy Star which seeks to help consumers identify higher performing products that meet a range of performance standards. In the case of cold appliances, this is typically 10-20% above the minimum requirement.

Energy Star was introduced for refrigerators in 1998 and expanded to cover all refrigerator and freezer appliances on 1 January 2003). The most recent addition of the Energy Star criteria were issued on 3 August 2007 and came into effect on 28 April 2008. In 2007, it was estimated that at least 30% of US refrigerators carried the Energy Star label⁶.

In addition there are a large number of regional, state and local policy interventions by a large number of bodies. Such interventions range from state based MEPS through major procurement activities (eg utility DSM programmes), often driven by requirements in states such as California and/or based on Energy Star qualified products.

⁵ The majority of policy information sourced from APEC-ESIS <http://www.apec-es.org/countrysummary.php?country=USA&ID=262>

⁶ http://www.energystar.gov/index.cfm?c=manuf_res_pt_appliances#asd

Cultural Issues (See Notes Section 6)

- 1) Overall number of refrigerators installed in US homes in 2001 was 126 million
- 2) Growth in the number of households with more than one refrigerator has been significant. In 1984, the percentage of households with more than one refrigerator was 12%, by 2001 this number was 17% (18.1 million households). This has led average consumption by refrigerators in household (in 2001) to be 1,462 kWh, significantly higher than the average UEC⁷ of 1,239 kWh, while U.S. households on average consumed for refrigeration

The difference between the average amount of electricity consumed to power one refrigerator and the average household consumption of electricity for refrigeration was even greater because secondary (less-used) refrigerators tend to be older and significantly less efficient than primary refrigerators. In 2001:

- The median age of primary refrigerators was 5 years to 9 years
- The median age of secondary refrigerators was 10 years to 19 years.

Department of Energy indicates refrigerators last an average of 14 years.

⁷ Unit energy consumption (UEC) provides a measure of electricity consumption per unit per year.

Notes on data

Section 1: Notes on Product Efficiency

1.1 Test methodologies, Performance Standards and Labelling Requirements

Appendices A1 and B1 Uniform test method for measuring the energy consumption of electric refrigerators and electric refrigerator-freezers and Uniform test method for measuring the energy consumption of freezers respectively that are based on ANSI/AHAM HRF-1-1988.

Test Standards in use by program:

- MEPS and EnergyGuide (a mandatory labeling program): 10 CFR Part 430 Subpart B Appendices A1 and B1, and ANSI / AHAM HRF 1-1988
- ENERGY STAR (a voluntary program): 10 CFR 430, Subpart B, Appendices A1 and B1

Specific information:

External Test Temperature: The energy test procedure simulates typical room conditions (approximately 21.1°C) with door openings, by testing at 32.2°C without door openings.

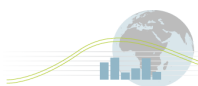
Internal Test Temperature: Varies but typically units tested at:

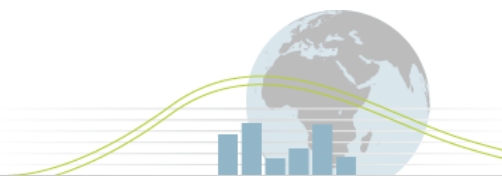
- 3.3°C for fresh food volumes (although it may rise to 7.2°C)
- -15°C freezer volume of refrigerator/freezer combinations
- 18°C for freezer only units

1.2 Product Classifications

(Source: CLASP: AHAM HRF-1-2004)

Product Type	
(1)	Refrigerators and refrigerator-freezers with manual defrost
(2)	Refrigerator-freezers with partial automatic defrost
(3)	Refrigerator-freezers with automatic defrost with top-mounted freezer without through-the-door ice service, and all refrigerators with automatic defrost
(4)	Refrigerator-freezers with automatic defrost with side-mounted freezer without through-the-door ice service
(5)	Refrigerator-freezers with automatic defrost with bottom-mounted freezer without through-the-door ice service





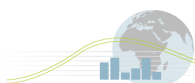
(6)	Refrigerator-freezers with automatic defrost with top-mounted freezer with through-the-door ice service
(7)	Refrigerator-freezers with automatic defrost with side-mounted freezer with through-the-door ice service
(8)	Upright freezers with manual defrost
(9)	Upright freezers with automatic defrost
(10)	Chest freezers and all other freezers
(11)	Compact refrigerators and refrigerator-freezers with manual defrost
(12)	Compact refrigerator-freezers with partial automatic defrost
(13)	Compact refrigerator-freezers with automatic defrost with top-mounted freezer and compact all-refrigerators with automatic defrost
(14)	Compact refrigerator-freezers with automatic defrost with side-mounted freezer
(15)	Compact refrigerator-freezers with automatic defrost with bottom-mounted freezer
(16)	Compact upright freezers with manual defrost
(17)	Compact upright freezers with automatic defrost
(18)	Compact chest freezers and all other freezers

1.3 Product Efficiency Graphic

Source: ENERGY STAR product database. For more information see: http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators

Key calculations undertaken:

Derived Total Model Volume: based on net volume (as defined in local regulations) with freezer compartment volume multiplied by a correction factor (in the USA, 1.63 for Refrigerator Freezers, 1.44 for Refrigerator Freezers of Type 1 and 11, and 1.73 for Freezers) to get equivalent fridge volume. Add this volume to the net fridge volume to establish the net total volume normalised to a refrigerator equivalent. This volume is the Derived Total Volume.



Derived Model Energy Consumption: based on total annual energy consumption under local test conditions, reducing consumption by 5% if the unit has an ice maker. This energy consumption is the Derived Unit Energy Consumption.

Derived Model Energy Efficiency: Equals Derived Model Energy Consumption divided by Derived Total Model Volume

Sales Weighted Energy Efficiency of New Models: (Sum of (Derived Model Energy Efficiency multiplied by sales volume of Model in year) for all Models) divided by (Sum of sales volume of all Models in year)

Model Weighted Energy Efficiency of New Models (used where no sales data is available): (Sum of Derived Model Energy Efficiency for all models sold in year) divided by (Number of Models sold in year).

In 2008, it was estimated that the ENERGY STAR database covered approximately 30%⁸ of all products available in the US market for domestic cold appliances. However, this is only an estimate and equivalent data for other years is not available.

Section 2: Notes on Product Consumption

2.1 Test methodologies, Performance Standards and Labelling Requirements

Refer to section 1.2

2.2 Product Classifications

Refer to section 1.2

2.3 Product Consumption Graphic

Refer to section 1.3

Section 3: Notes on Efficiency of Stock

None

Section 4: Notes on Consumption of Stock

Source: Energy information Administration:

- Number of products - "Two Decades of U.S. Household Trends in Energy-Intensity Indicators: A Look at the Underlying Factors." 2005. Available at: http://www.eia.doe.gov/emeu/efficiency/2005_IAEE.pdf
- Stock consumption: U.S. household electricity report. Available at: http://www.eia.doe.gov/emeu/reps/enduse/er01_us.html

⁸ http://www.energystar.gov/index.cfm?c=manuf_res_pt_appliances#asd

Section 5: Notes on Policy Interventions

Minimum Energy Performance Standards

The U.S. government established a mandatory compliance program in the 1970s requiring that certain types of new appliances bear a label to help consumers compare the energy efficiency among similar products.

Minimum standards of energy efficiency for many major appliances were established by the U.S. Congress in the National Appliance Energy Conservation Act (NAECA) of 1987, and in the National Appliance Energy Conservation Amendments of 1988. Standards for some fluorescent and incandescent reflector lamps, plumbing products, electric motors, and commercial water heaters, heating, ventilation and air conditioning (HVAC) systems were added in the Energy Policy Act of 1992 (EPACT). The US Department of Energy (DOE) is responsible for developing the standards and test procedures for the Appliance Standards Program as well as periodically issues new standards for specific appliances.

In December 2007, the Congress enacted H.R. 6, requiring that DOE complete a rulemaking to consider strengthened standards for residential refrigerators by December 31st, 2010. Any amended standard would become effective January 1st, 2014. (Appliance Standards Awareness Project, February 2008)

The product is required to be tested in accordance with Federal test procedures to meet mandated efficiency standards. This test procedures can be found in the current U.S. Code of Federal Regulations (CFR, Title 10, Part 430 Appendix A1 and B1)

Statutory Authority

The Energy Policy and Conservation Act (EPCA) (42 U.S.C. 6291, *et seq.*) established the Energy Conservation Program for Consumer Products Other than Automobiles, covering major household appliances including residential refrigerators, refrigerator-freezers, and freezers. The National Appliance Energy Conservation Act of 1987 subsequently amended EPCA by establishing energy conservation standards for residential refrigerators, refrigerator-freezers, and freezers. The Energy Independence and Security Act of 2007 (EISA) then required the U.S. Department of Energy (DOE) to review and amend energy conservation standards for residential refrigerators, refrigerator-freezers, and freezers. DOE is currently developing amended standards pursuant to 42 U.S.C. 6295(b)(4).

Rulemakings Under Development

- Energy Conservation Standards Framework Document⁹

Past Rulemakings

⁹ http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/refrbod.pdf

- Energy Efficiency Standards for Refrigerators, Refrigerator-Freezers and Freezers Technical Support Document, October 2005¹⁰
- Energy Conservation Program for Consumer Products: Test Procedure for Refrigerators and Refrigerator-Freezers Direct Final Rule, *Federal Register*, March 7, 2003¹¹
- Energy Conservation Program for Consumer Products: Test Procedure for Refrigerators and Refrigerator-Freezers Notice of Proposed Rulemaking, *Federal Register*, March 7, 2003¹²
- Energy Conservation Program for Consumer Products: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers and Freezers Final Rule, *Federal Register*, April 28, 1997¹³

Public Statement on Proper Implementation of Refrigerator-Freezer Test Procedure

DOE issued a public statement on the proper implementation of the DOE refrigerator-freezer test procedure, including the industry test procedure which is incorporated by reference (American National Standards Institute/Association of Home Appliance Manufacturers Standard HRF-1-1979, Household Refrigerators, Combination Refrigerator-Freezers and Household Freezers)¹⁴.

Mandatory Labelling: EnergyGuide

In 1980, the Federal Trade Commission (FTC) â€™s Appliance Labeling Rule became effective, and requires that EnergyGuide labels be placed on all new appliances. The FTC is responsible for the design, implementation and compliance of this program. The National Institute of Standards and Technology (NIST) is responsible for the test procedures.

The EnergyGuide label on refrigerators indicate how much electricity in kilowatt-hours (kWh) a particular model uses in one year. The program covers refrigerators or refrigerator-freezers with a cabinet designed for the refrigerated storage of food at temperatures above 32° F., 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., but does not provide a separate low temperature compartment designed for the freezing and storage of food at temperatures below 8° F. An "all-refrigerator" is an electric refrigerator which does not include a compartment for the freezing and long time storage of food at temperatures below 32° F (0.0° C). An "all-refrigerator" may include a compartment of 0.50 cubic capacity (14.2 liters) or less for the freezing and storage of ice.

The New EnergyGuide Label

The Federal Trade Commission announced in August, 2007 that it has concluded a two-year review of the FTC's Appliance Labeling Rule (16 C.F.R. Part 305) and, after substantial

¹⁰ http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/refrigerators_tp_direct_final_rule.pdf

¹¹ http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/refrigerator_report_1.pdf

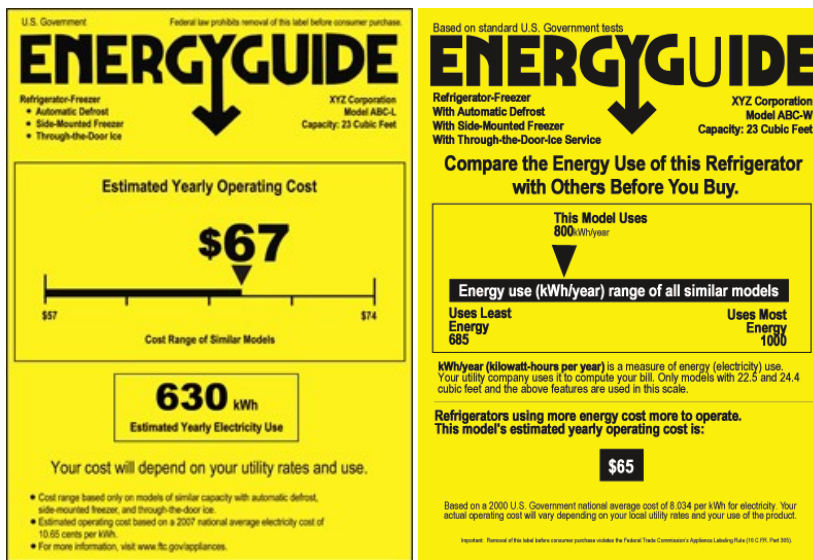
¹² http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/refrigerators_tp_nopr.pdf

¹³ http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/reffrbod.pdf

¹⁴ http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/res_refridge_freezers_tp_statement.pdf

public comment and consumer research, has amended the Rule to improve the design and content of the EnergyGuide label required on most new appliances sold in the United States¹⁵. The yellow EnergyGuide label, familiar to most appliance shoppers, helps consumers compare the "operating costs" of competing models and aids them in identifying high-efficiency models that will reduce their energy use.

The new EnergyGuide label has a streamlined look and will display estimated yearly operating costs prominently for most appliance types. This estimated cost information, which will appear on the labels in dollars per year, will provide consumers with a clear context to compare the energy efficiency of different appliance models. It also will help consumers assess trade-offs between the energy costs of their appliances and other expenditures. The new EnergyGuide label design will continue to display energy consumption information (e.g., annual electricity use) as a secondary disclosure for most labeled products.



Voluntary Labelling: Energy Star

Energy Star is jointly managed by the Environment Protection Agency (EPA) and the US Department of Energy (DOE) since 1992 as a voluntary, market-based partnership that seeks to reduce air pollution through increased energy efficiency. The program is originally covered only computers, monitors and printers, but has now been expanded to cover a wide variety of appliances, equipment, building products and homes and windows. Products that have earned the Energy Star designation prevent greenhouse gas emissions by meeting strict energy-efficiency specifications set by the government.

Labelling Requirement:

All models must be automatic defrost. Top-freezer models must be at least 12.5 ft³ in total (refrigerator plus freezer) volume. Side-by-side and bottom-freezer models must be at least 18.5 ft³ in total volume.

¹⁵ <http://www.ftc.gov/os/2007/08/070807appliancecure.pdf>

To qualify for the label, models which meet above criteria must use 10% less energy than the July 1, 2001 MEPS level or minimum federal standards for a refrigerator of that size and configuration.



In 2007, it is estimated that at least 30%¹⁶ of refrigerators in the US are qualified to carry the Energy Star Label.

Section 6: Notes on Cultural Issues

Overall number of refrigerators installed in US homes in 2001 was 126 million¹⁷

Unit energy consumption (UEC) provides a measure of electricity consumption per unit per year. For refrigerators in 2001, the average UEC was 1,239 kWh, while U.S. households on average consumed 1,462 kWh for refrigeration. The average for household consumption was higher than the average UEC due to an upward trend in the number of households with more than one refrigerator. In 1984, 12 percent of households had two or more refrigerators; by 2001, 17 percent (18.1 million households) did.

The difference between the average amount of electricity consumed to power one refrigerator and the average household consumption of electricity for refrigeration was even greater because secondary (less-used) refrigerators tend to be older than primary refrigerators. In 2001, the median age of primary refrigerators was 5 years to 9 years, whereas the median age of secondary refrigerators was 10 years to 19 years (according to the US DOE, refrigerators last an average of 14 years¹⁸). Because older units are typically less efficient than newer units, secondary refrigerators drive up the U.S. household average consumption of electricity for refrigeration, leaving significant potential for a reduction in total electricity consumption by refrigerators.¹⁹

Detailed information on energy use within US households, with associated trends and drivers can be found in the Energy Information Administration's "Residential Energy Consumption Survey Home Energy Uses and Costs"²⁰

¹⁶ http://www.energystar.gov/index.cfm?c=manuf_res.pt_appliances#asd

¹⁷ "Two Decades of U.S. Household Trends in Energy-Intensity Indicators: A Look at the Underlying Factors." 2005. Energy Information Administration. Available at http://www.eia.doe.gov/emeu/efficiency/2005_IAEE.pdf.

¹⁸ <http://www1.eere.energy.gov/consumer/tips/appliances.html>.

¹⁹ http://www.eia.doe.gov/emeu/reps/enduse/er01_us.html.

²⁰ <http://www.eia.doe.gov/emeu/recs/contents.html>