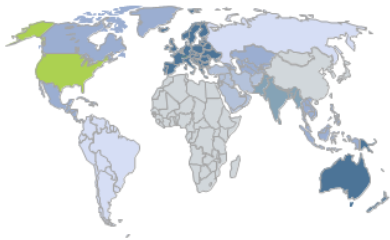
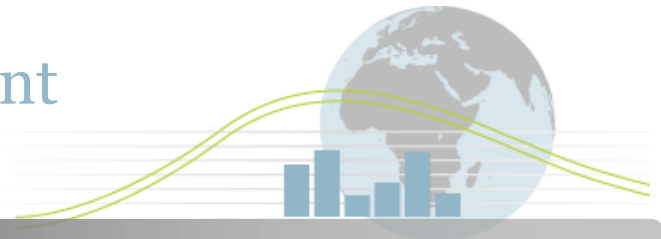


4E

Mapping Document



Country:	USA
Technology:	Vending Machines
Sub Category:	Beverage only (can/bottle)

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:

Self-contained refrigerated systems designed to accept consumer payments or tokens to dispense pre-packed beverages (cans/bottles/food packets) at between 3°C and 12°C without on-site labour intervention

Hence data was sought on the energy performance of the following product types:

- Beverage (can/bottle)
- Food/Snack (spiral, carousel or other vend type)¹

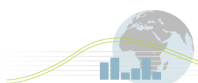
Other characteristics to be noted:

- Capacity - number of cans / bottles / snacks or volume (litres)
- Storage temperature
- Ambient temperature during test
- Whether for indoor or for outdoor use
- Capability of automatically switching into a low power mode
- Presence of usage sensor or timer to enable low power modes
- Refrigerant used
- Glass fronted or solid

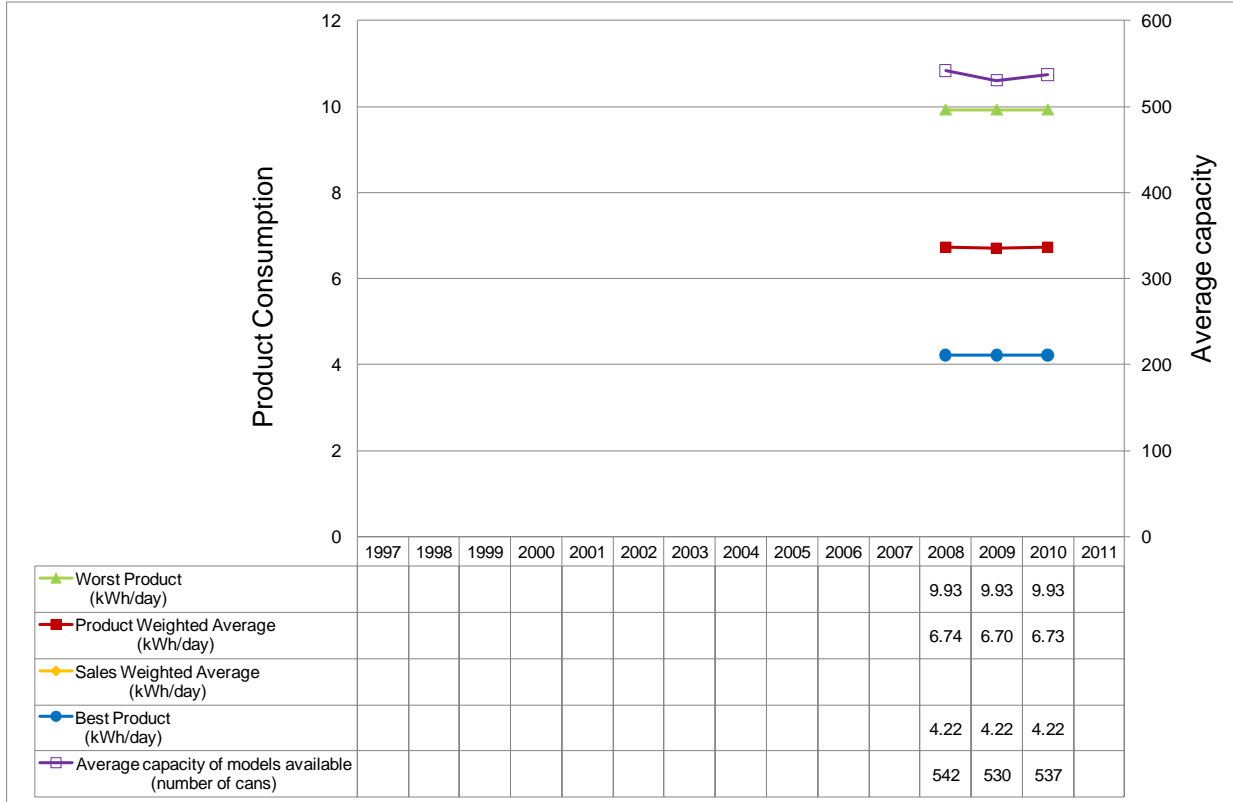
A full product definition is provided at the annex website².

¹ No data were available on this product type and so these are not included in the analysis.

² see <http://mappingandbenchmarking.iea-4e.org/matrix?type=product&id=8>



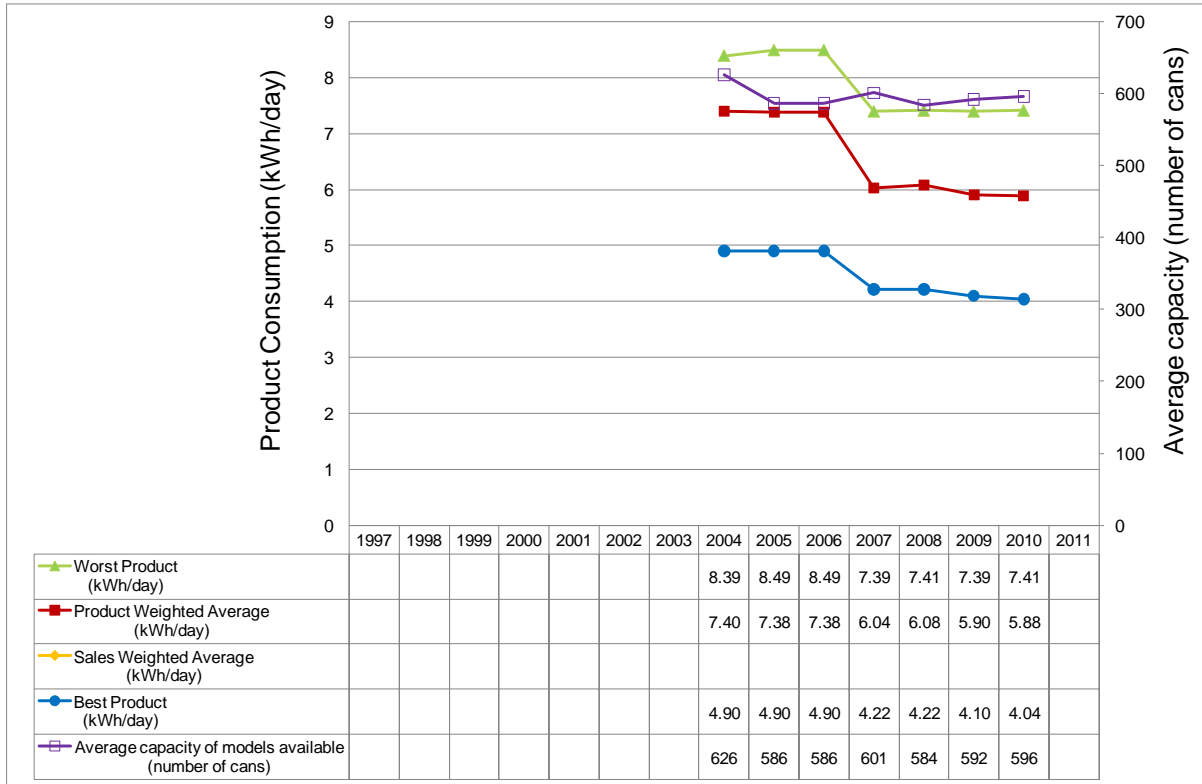
Energy consumption of new beverage vending machines - USA California Energy Commission



Key notes on Graph (see notes section 1)

- Data were downloaded from the California Energy Commission web site. California has a regulatory minimum requirement equal to the Tier 1 ENERGY STAR requirement (which was in effect under ENERGY STAR from 2004 to June 2007).
- Numbers of products included in the California data set varied between 10 (2006/2007) to 42 (2010). The data for 2006 and 2007 were deleted as having too few products to be representative of the market. This includes products carried forward from registration in previous years on the assumption that they would remain on the market for six years.
- All data are normalised to appear as if testing was carried out at outdoor ambient conditions (as per ASHRAE 32.1 test standard).

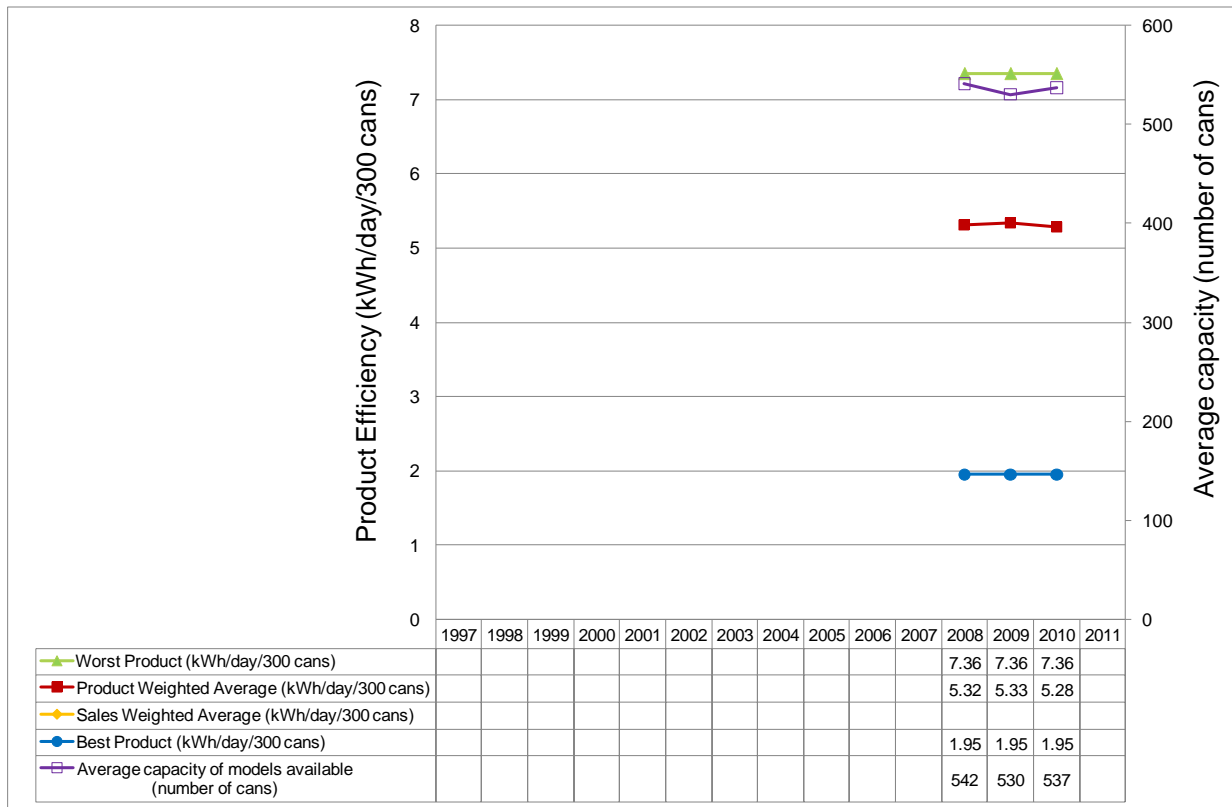
Energy consumption of new beverage vending machines - USA ENERGY STAR



Key notes on Graph (see notes section 1)

- Data were provided from the ENERGY STAR database for beverage vending machines which includes only better performing machines (aiming for top 25% of the market). ENERGY STAR criteria became more stringent under Tier 2 requirements from 1 July 2007.
- Numbers of products included in the ENERGY STAR data set varies from 42 (2004) to 93 (2010). This includes products carried forward from registration in previous years on the assumption that they would remain on the market for six years.
- All data are normalised to appear as if testing was carried out at outdoor ambient conditions (as per ASHRAE 32.1 test standard).

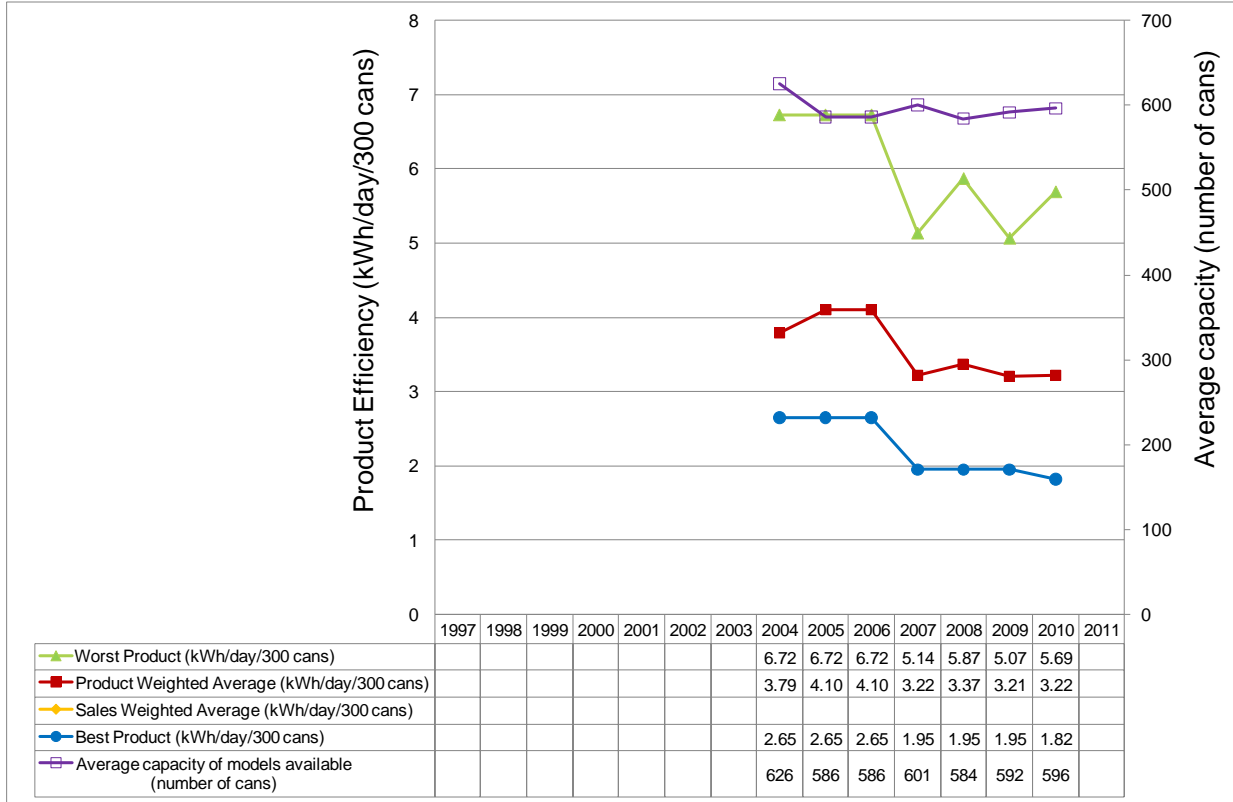
Energy efficiency of new beverage vending machines - USA California Energy Commission



Key notes on Graph (see notes section 2)

- Data were downloaded from the California Energy Commission web site. California has a regulatory minimum requirement equal to the Tier 1 ENERGY STAR requirement (which was in effect under ENERGY STAR from 2004 to June 2007).
- Numbers of products included in the California data set varied between 10 (2006/2007) to 42 (2010). The data for 2006 and 2007 were deleted as having too few products to be representative of the market. This includes products carried forward from registration in previous years on the assumption that they would remain on the market for six years.
- All data are normalised to appear as if testing was carried out at outdoor ambient conditions (as per ASHRAE 32.1 test standard).

Energy efficiency of new beverage vending machines - USA ENERGY STAR



Key notes on Graph (see notes section 2)

- Data were provided from the ENERGY STAR database for beverage vending machines which includes only better performing machines (aiming for top 25% of the market). ENERGY STAR criteria became more stringent under Tier 2 requirements from 1 July 2007.
- Numbers of products included in the ENERGY STAR data set varies from 42 (2004) to 93 (2010). This includes products carried forward from registration in previous years on the assumption that they would remain on the market for six years.
- All data are normalised to appear as if testing was carried out at outdoor ambient conditions (as per ASHRAE 32.1 test standard).

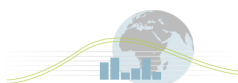
Total energy consumption in the existing beverage vending machine stock – USA

(See Notes Section 3)

- No specific data on the installed stock of vending machines in the USA were available to the Annex at the time of publication.
- However, the Final Rule for beverage vending machines³ states that the stock of machines in the USA was 2.3 million in 2009 and anticipated a stock shrinkage to 1.6 million units ‘in the short term as the 1998–2000 vintage equipment retires faster than it is replaced’ and a recovery to 1.9 million units by 2020⁴.
- The California Energy Commission stated in their publication Update of Appliance Efficiency Regulations of November 2004 (document ref 400-04-007F) that there were “approximately 300,000 beverage vending machines in service in California”, with annual sales of 41,000 and an average per-unit energy use of 3,077 kWh per year.

³ See http://www1.eere.energy.gov/buildings/appliance_standards/commercial/beverage_machines.html

⁴ Page 44929 under the heading “4. Future Sales Decline”, from Federal Register/Vol. 74, No. 167/Monday, August 31, 2009/Rules and Regulations.



Major Policy Interventions (See notes Section 4)

There are three major policies applicable to vending machines in the USA: ENERGY STAR voluntary label for the most efficient products; federal MEPS are due to come into force 31 August 2012, and California has had MEPS since 2004 equal to the requirements that applied under ENERGY STAR between 2004 and 2007. Each is considered in more detail below.

ENERGY STAR

Refrigerated beverage (can/bottle) vending machines have been covered by the USA ENERGY STAR voluntary labelling programme since 2004⁵. The ENERGY STAR programme does not include snack or beverage/snack hybrid units. The ENERGY STAR programme recognises that location (Indoor vs indoor/outdoor) of a beverage vending unit has significant impact on energy consumption as the compressor must work harder in high temperature/high humidity conditions (as experienced more often outdoors) to maintain the product temperature. ENERGY STAR identifies the intended location of usage for the machine in the qualified product lists. While the efficiency criteria are the same for both types, the requirements for ambient temperature and humidity during test are different.

The ENERGY STAR criteria stipulate a design requirement to have a hard-wired automatic low power state for lighting and/or for refrigeration system, combined with two tiers of daily energy consumption requirements:

- Tier 1 covered April 2004 to 30 June 2007 and required a maximum daily consumption of $0.55 [8.66 + (0.009 \times C)]$
- Tier 2 came into force 1 July 2007 and requires a daily consumption of less than $0.45 [8.66 + (0.009 \times C)]$

Where C is the vendible capacity (the maximum quantity of standard product that can be dispensed from one full loading of the vending machine without further reload operations). And energy consumption is kWh per 24 hours.

Hence a machine with a vendible capacity of 570 cans, and a refrigerated volume of 900 litres (31.8 cubic feet) would have a Tier 1 limit of 7.58 kWh/day and Tier 2 of 6.21 kWh/day.

Federal MEPS

Mandatory Federal MEPS will apply to all beverage vending machines manufactured for sale in the United States, or imported to the United States, from August 31 2012⁶. These MEPS

⁵ See http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=VMC

⁶ Note that the published date of entry into force in the original final rule was wrong, and corrected in a subsequent final rule to be 31 August 2012, being three years after original publication.

are under the US Department of Energy 's Final Rule 10 CFR Part 431 Energy Conservation Program: Energy Conservation Standards for Refrigerated Bottled or Canned Beverage Vending Machines⁷. This rule is also based on the test standard ASHRAE 32.1 and imposes a maximum daily energy consumption figure. The limit is a function of the internal refrigerated volume of the unit (in cubic feet). The MEPS do not apply to those vending food, snacks and other products.

Two types of machine are defined with slightly different daily consumption limits:

- Type A machines are those for which the entire product stock (in the refrigerated volume) is held at the same uniform temperature, ready to vend. Type A machines typically have a transparent front and can vend a range of different beverages from a shelf-style layout from which the customer selects their choice. The maximum daily energy consumption (MDEC) is $0.055 \times V + 2.56$.
- Type B machines vend from a stack of products of which only the few next in line to be vended are cooled to the specified vend temperature. The majority of the stock is held at a higher temperature. Type B machines typically have an opaque front. MDEC for type B machines is $0.073 \times V + 3.16$.

Where V is refrigerated volume in cubic feet, MDEC is in kWh per day.

Hence a machine with a vendible capacity of 570 cans, and a refrigerated volume of 900 litres (31.8 cubic feet) would have to meet a daily energy limit from 31 August 2012 of 4.31 kWh/day if of Type A, and 5.48 kWh/day if Type B.

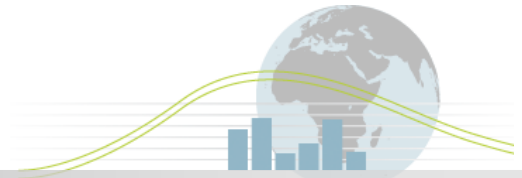
California MEPS

The California Energy Commission has had in place minimum standards for beverage vending machines since 1 January 2006⁸. The requirement in kWh per day coincides with the ENERGY STAR Tier 1 requirements of less than $0.55 \times (8.66 + (0.009 \times C))$ (where C is the 'rated capacity in number of 12 ounce cans') combined with a design requirement to have a hard-wired automatic low power state for lighting *and* refrigeration system. Note that ENERGY STAR requires an automatic low power state for lighting *and/or* refrigeration system.

Note: The Californian regulation distinguishes machines capable of dispensing over 20 discrete types of beverage, which are defined as 'multi-package' beverage vending machines. These multi-package machines are subject to the same daily energy and design requirements but suppliers of these are requested to supply internal volume data for such units. This is similar to a machine definition used in Canada.

⁷ See http://www1.eere.energy.gov/buildings/appliance_standards/commercial/beverage_machines.html

⁸ See Appliance Efficiency Regulations, (California Code of Regulations, Title 20, Sections 1601 through 1608), dated September 2010 available from <http://www.energy.ca.gov/appliances/>



Cultural Issues (See Notes Section 5)

No information available.



Notes on data

Section 1: Notes on Product Efficiency

1.1 Test methodologies, Performance Standards and Labelling Requirements

In the USA energy performance of refrigerated beverage vending machines for ENERGY STAR, Federal and Californian MEPS is measured according to ASHRAE Standard 32.1-2004, Methods of Testing for Rating Vending Machines for Bottled, Canned, and Other Sealed Beverages.

Summary of test method requirements for ambient temperature and storage temperature, for ASHRAE 32.1 for vending machines.

Test method	'Indoor' type product		'Outdoor' type product	
	Ambient temperature (DegC)	Ambient humidity (%RH)	Ambient temperature (DegC)	Ambient humidity (%RH)
ASHRAE 32.1 (USA, Canada, Australia) and AS/NZ 4864.1:2008	23.9°C±1°C	45%±5%	32.2°C±1°C	65%±5%

MEPS have been imposed for California and will apply federally from 31 August 2012 to all refrigerated beverage vending machines (see Policy section).

Labelling is not mandatory although suppliers may use the ENERGY STAR label for compliant and registered products.

1.2 Product Efficiency Graphic

Data were supplied by the US Environmental Protection Agency for ENERGY STAR and were also downloaded from the California Energy Commission (CEC) product data base⁹. Registration for ENERGY STAR is voluntary, but all products intended for sale in California must be registered with CEC. Data were only available for beverage (can/bottle) type vending machines, with no data for food/snack machines.

It was assumed that vending machines will stay on the market for six years after first registration: data on products registered in any given year were carried forward to also be included in the data set for the following five years.

⁹ See <http://www.appliances.energy.ca.gov/AdvancedSearch.aspx>

ENERGY STAR data

Data were available for products on the market in 2004 to 2010 inclusive and varied between 52 products (2004) and 93 products (2010). This included products carried forward from registration in previous years on the assumption that they would remain on the market for six years. Historical databases were provided (snapshots in each year from that time). Data were available on rebuilt machines from 2007, in addition to data on new machines. The data for rebuilt and new machines were combined into a single data set as the rebuild process generally involves complete reconstruction (little other than the chassis is usually re-used) and so the rebuilt products can be assumed to perform at a similar level to the new machines.

California Energy Commission data

The database download from the CEC web site included a date added field. This was used to filter out products made available in each year and so create a time series data set. Data were available for products on the market in 2006 to 2010 inclusive and varied between 10 products (2006/07) and 42 products (2010). This included products carried forward from registration in previous years on the assumption that they would remain on the market for six years.

Normalisation of all data

Ambient temperature during test affects the energy consumption of the machine – consumption rises (or falls) by around 3% for each additional (or reduced) degree Celcius of ambient temperature above the internal storage temperature of the machine.

To make data comparable, all were normalised for internal storage temperature and for ambient temperature during test (carried out for both consumption and efficiency results):

- i. Storage temperature: as if tested with a storage temperature of 4.4°C (where this was made possible by any declared storage temperature). This was done assuming 3% change in consumption for every degree Celcius difference.
- ii. Ambient temperature: as if tested at the ASHRAE outdoor requirement as per the table above. This was also done assuming 3% change in consumption for every degree Celcius difference.

The internal product temperature during test was assumed to be 4.4°C in all cases (standard requirement for soft drinks).

Section 2: Notes on Product Consumption

2.1 Test methodologies, Performance Standards and Labelling Requirements

Test methodology used for consumption is exactly as above for efficiency.

2.2 Product Consumption Graphic

Data sources for this graphic are exactly as for efficiency above.

Section 3: Notes on Consumption of Stock

No data were available on consumption of stock.

Section 4: Notes on Policy Interventions

No further information available.

Section 5: Notes on Cultural Issues

No further information available.