Product Definition: Vending Machines

11 May 2011

1. Summary Definition and Categorisation

This work covers refrigerated vending machines. Following consultation with all participant countries, the definition and categorisation shown in Table 1 is proposed for these products. Sections 2 and 3 explain the rationale for this in more detail. See also the supplementary document 'Product Analysis Proposal and Budget: Refrigerated Vending Machines' for further information on how the data will be analysed.

Table 1: Simplified Product Categorisation Matrix

Definition & scope	***Self-contained refrigerated systems designed to accept consumer payments or tokens to dispense pre-packed beverages (cans/bottles/food packets) at between 0°C and 5°C without on-site labour intervention.***[1]	
Type	Beverage (can/bottle)	Food/Snack (spiral, carousel or other vend type)
Capacity	Number of cans / bottles / snacks that can be stored in the carousel (units). Or (for food/snack only): Internal volume of refrigerated storage space (litres) (This allows dividing products into size categories small, medium, large)	
Other characteristics to be noted:	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 (i.e. whether or not the product can be seen from the outside)	

Note that the following types of vending machines are excluded:

- Hot and cold beverage vending machines that dispense into a cup
- 'Point of use' water dispensers, for which water is dispensed from a bottle/reservoir or mains water source
- Non-refrigerated vending machines.

[1] Definition is derived from the ENERGY STAR and European Vending Association definitions.

2. Product Sub-Category Rationalisation

This section explains the rationale behind the summary definition presented in Section 1, and how this was developed. Table 2 shows the first proposed way to break down the product category, and each aspect is discussed sections 2.1 to 2.2.

Table 2: Initial matrix definition of possible vending machine sub-categorisation.

		Aspect	**Possible Permutations**				
A	Technology	Timers for lighting etc	Built-in timer, factory or user set, to switch lights off or enable other energy saving functions.				No timed energy saving features.
B	Technology	Usage sensors	With built-in usage detection to switch to low power mode (motion sensor, vend frequency sensor etc)				No usage sensing; no automatic switch to low power mode.
C	Technology	Refrigerant / foam blowing agent	Refrigerant could be of various types including natural refrigerants (propane/butane) and HFC / HCFC types with different inherent efficiency and different Global Warming Potential (GWP) if leaked to atmosphere. There are similar issues for the gas used as blowing agent in the insulation foam, which could be natural, HFC or HCFC.				
D	Functionality	Type of product to vend	Dedicated Can & bottle beverages	Food & snack, spiral / carousel / other vend type	Hot (and cold) drinks machines dispensing into cups (tea / coffee / cold drink)	Point of use water / beverage (e.g. reservoir or plumbed in water dispenser)	Non-food items (toiletries, cigarettes, household items etc)
E	Functionality	Food safety issues and low power modes	For perishable food / drink (lights can be turned off, but refrigeration must continue)				Non perishable food / drink (option to switch off refrigeration and lights)
F	Functionality	Storage temperature	Frozen	Refrigerated	Ambient	Mixed temperatures	
G	Functionality	Capacity	Machines vary in the number of cans / beverages / food items they can hold. This may affect energy consumption and energy efficiency.				
H	Functionality	Location	For indoor use.			For outdoor use	
I	Functionality	Visibility of products	Products on display (e.g. through glass front)				Products hidden (as often with beverage vending)
J	Functionality	Payment	Capable of receiving payments / tokens				Free vend

2.1 Technology

Matrix Row A): Timers for lighting etc

In recent years many products have come onto the market with a built-in timer to switch off lighting during quiet hours as a specific energy saving feature. Some timers may also trigger other low energy features, such as allowing internal temperature to rise for non-perishable contents. The presence of this feature is a choice for manufacturers and buyers and does not affect functionality to users. It therefore does not merit separation from conventional products in this analysis. The ASHRAE 32.1 test methodology requires that any energy saving features that are adjustable by the operator shall be switched off during test (i.e. only hard-wired non-adjustable energy saving features will be taken into account in testing). Note: LED lighting has become common in the past couple of years as an energy saving measure. This is doubly effective as LEDs also generate less heat that has to be removed by the refrigeration system.

- *Proposal: To analyse products with timers alongside conventional products. Noting presence of this feature will be invited as one of the product characteristics.*

Matrix Row B): Usage sensors

A more advanced energy-saving feature present in some products is autonomous sensing of when quiet periods have been reached, allowing lighting to be turned off or turned down and in some cases a low-power Refrigeration mode to be adopted. These sometimes rely on a motion sensor mounted on the machine, or perhaps by the average time between vending operations. This is similar to timers above, and does not merit separation from conventional products. As above, ASHRAE 32.1 requires such features that are adjustable by the user to be switched off during test.

- *Proposal: To analyse products with usage sensors alongside conventional products. Noting presence of this feature will be invited as one of the product characteristics.*

Matrix Row C): Refrigerant / foam blowing agent

Most refrigerated vending machines use electric vapour compression refrigerators which make use of chemical refrigerants such as halocarbons (HFC or HCFC) or natural refrigerants such as propane/butane. Different refrigerants have different inherent efficiencies, and associated global warming potentials (GWP). Similar chemicals are used as blowing agents to make the foam insulation, with similar environment impacts if they are released to the atmosphere. This is a simple choice by the manufacturer (and specifier) and does not affect functionality for the user. It does not merit separation from conventional products.

- *Proposal: To analyse products all together regardless of which refrigerant and blowing agent are used, but to invite information on this secondary characteristic if available.*

2.2 Functionality

Matrix Row D): Type of product to vend and type of vending machine

The first principal differentiation to make amongst vending machines is whether or not they are refrigerated. Refrigeration is usually left running 24 hours a day, 365 days per year (even for non-perishable goods) and there is significant scope to reduce energy consumption through improved refrigeration efficiency, improved insulation and better controls.

Considering non-refrigerated, hot drinks vending machines are also significant energy consumers in Europe[2] and often keep liquid hot ready to serve all the time. There is less information about energy consumption of hot drinks machines, and there is probably less scope for savings because a significant amount of the energy consumed is “sold” in the hot drinks. Hot drinks machines are also less common outside of Europe. Energy consumption of other non-refrigerated machines is usually very low, restricted to lighting and electromechanical operation during vend with little scope for reductions. It is therefore proposed to focus only on refrigerated vending machines for this analysis.

The next differentiation is between the types of machine vending pre-packaged food and drink. There are three principal types, with an indicative market share for the EU as follows (as identified in the EU eco-design regulation preparatory study[3]):

- Cans & bottles machines, with 30 % of EU market share
- Snack/drink ‘spiral’ machines vending food and/or bottles/cans, with 55% to 60% of EU cold vending market share by unit sales
- Carousel machines (vending cold food and/or drinks), with 10% to 15% of EU market share.

[2] One UK government study suggested that there are nearly 1.7 times as many hot and cold beverage dispensing machines as there are refrigerated vending machines in the UK, and that in total these beverage dispensers consume nearly 1.5 times as much energy as the refrigerated machines. From BNCR VM02 Cold Vending Machines Government Standards Evidence Base 2009 – Reference Scenario, from http://efficient-products.defra.gov.uk/cms/product-strategies/subsector/commercial-refrigeration.

[3] European Commission DG TREN, Preparatory Studies for Eco-design Requirements of EuPs TREN/D1/40-2005/LOT12/S07.56644], Lot 12 Commercial refrigerators and freezers, Final Report, December 2007, from http://www.ecofreezercom.org/docs/BIO_EuP_Lot_12_Final_Report.pdf .

This approximate distribution of market share is backed up by an Australian government report[4] which found that refrigerated beverage (cans and bottles) vending machines (including both glass fronted so that products are visible, and the closed type) account for 75% of the energy consumed by all refrigerated vending, i.e. refrigerated food and snack and mixed vending accounts for around 25% of energy consumption.

Additional note following further information obtained during data analysis: In the EU dedicated can/bottle machines are far less common than in the USA, Canada and Australia. A majority of EU customers use food/snack spiral vend glass fronted machines to vend cans and bottles. This is often done in mixed snack and drink 'spiral' vend machines, but also by configuring the glass fronted spiral vend machines to carry only cans/bottles. It is therefore appropriate to group EU glass fronted spiral products (ensuring that the capacity and test results are appropriate to the '330ml can only' configuration) alongside the USA/Canadian/Australian dedicated can/bottle machines. This will show up any efficiency differences between the way in which the EU market chooses to vend its drinks compared to other markets.

Overall, it was decided that dedicated refrigerated beverage (bottle/can) vending machines should be the primary focus of this analysis. This product is already the subject of an ENERGY STAR category in the USA, and also MEPS in Australia, Canada and the USA.

Spiral and carousel are basically alternative ways to dispense the product, and other ways are available. All of these rely on providing a refrigerated space in which to store the product. It is therefore not proposed to try and distinguish food and snack machines by delivery mechanism and they will simply be grouped as 'snack/drink machines'. Data on refrigerated snack/drink machines will be invited, although less energy performance information is likely to be available for these as there are fewer if any specific policies / regulations applicable to them.

A final type of refrigerated machine to be considered is the refrigerated water dispenser (although not strictly vending machine as they have no payment mechanism). These can serve water from a large bottle/reservoir, or be plumbed into a mains water supply. They tend to be left on 24 hours a day, 365 days per year. However, these units have significantly smaller refrigeration packs than beverage vending machines. One UK study[5] indicated that an office chilled water dispenser probably consumes less than 5% of the energy of a typical beverage vending machine. The same study estimated that point of use water dispensers accounted for around 3% of total refrigerated vending consumption in the UK. It is proposed that this type of vending machines be excluded from this analysis.

- *Proposal: To primarily focus on refrigerated beverage (bottle and can) vending machines for this analysis. But also to invite data on refrigerated snack / drink machines (which can be of the spiral, carousel, or other types) where this is available using the same metrics and test methodology.*

Matrix Row E): Food safety issues and low-power modes.

Vending machines containing perishable foods such as sandwiches, wraps, plated meals must continue refrigerating 24 hours a day to ensure food safety, although lights can be turned off (temperature must not rise above 8°C according to some regulations, depending upon the food type). Machines containing non-perishable foods can be safely switched off or into a low-power mode during quiet hours since refrigeration is for consumer satisfaction rather than safety. Modern machines may allow internal temperature to rise during quiet hours, and be programmed to begin refrigerating early enough for contents to be at the ideal temperature again before the normal operational period is reached. The majority of beverage vending machines fall into the non perishable foods category, and it may be a user choice whether or not to take advantage of low

[4] Australia and New Zealand government Equipment Energy Efficiency Committee, Regulatory Impact Statement Consultation Draft, Minimum Energy Performance Standards and Alternative Strategies for Refrigerated Beverage Vending Machines, September 2008, prepared by Niskin Enterprises Pty Ltd.

[5] See Footnote 2

energy settings. When a vending machine is used to contain perishable foods, there is usually a user option to prevent the machine entering any low energy mode. The ENERGY STAR criteria require vending machines to have a low energy mode but energy consumption is measured in the normal idle mode, in common with the Canadian and Australian schemes. It is therefore highly unlikely that a significant amount of low energy mode data will be available. Whether or not a vending machine is capable of a low energy mode will therefore be invited as a parameter. See also Section 3 *Metrics* below.

- *Proposal: To invite data that differentiates products capable of switching automatically into one or more low energy modes, and also the power demand when in such a mode.*

Matrix Row F): Storage temperature

As discussed above, this analysis will focus on refrigerated vending machines, generally operating between 0°C and 5°C, and excludes ambient vending. In practice, the major soft drinks suppliers who dominate the market specify a certain optimum temperature for serving their products which is the same the world over, and hence have had a useful normalising effect. The average beverage temperatures for test situations in test standard ASHRAE 32.1 are between 0.6°C to 4.4°C. The standard also requires that the "next to be vended" temperature shall be stabilised to 2.2±0.5°C during the energy consumption test and the vending test shall continue until product is coming out at 4.4°C or until half the product is vended. Beverage machines are often designed to vend product at the required 2.2°C but to store the bulk of the cans at a temperature a couple of degrees higher. The first few cans 'in the queue' get chilled further as they approach vend, which saves energy by requiring a higher overall storage temperature. The storage temperatures of beverage machines are therefore likely to be highly comparable.

The proportion of the market that is represented by frozen vending is extremely small and does not merit inclusion in this analysis. Some machines have mixed temperature capacity – but this is thought to represent a small part of the market and would create too much complexity to normalise. Mixed temperature machines will therefore be excluded from the analysis.

- *Proposal: To include only products intended for refrigerated vending operating at around 0°C to 5°C, inviting data on what temperature is actually used for test. Frozen, ambient and mixed temperature storage machines will be excluded.*

Matrix Row G): Capacity of vending machine

The ENERGY STAR and Canadian MEPS criteria set a maximum power as a function of the maximum number of cans/bottles/packets of food that the machine carousel can store. But the physical space required for (say) 550 cans will depend on the size of can, whether 12oz (in US, which is 355ml), or 330ml, or 500ml or other. The performance difference between a machine designed for 650 12oz (355ml) cans compared to one designed for 650 330ml cans is not considered significant and so that particular US/EU can size difference will be noted but not influence the analysis approach. Hence the number of bottles/cans will be requested as a data field to enable differentiation by capacity for beverage vending machines, plus size of bottle/can if available. At the national market level, it would also be useful to know which is the predominant drinks container type and size in order to calibrate comparisons of average machine performance between markets (e.g. if the US market is (say) predominantly 355 ml cans, compared to a European market of (say) 70% 500 ml bottles, then European machines may well be proportionately slightly larger and so expect slightly different energy consumption and efficiency).

The capacity of snack/drink vending machines (of spiral or carousel type) could be quantified by the number of food/drink packets that can be stored, but these vary significantly in size. This is appropriate where these machines are configured to vend only 330ml cans, when their efficiency can be compared directly with dedicated can/bottle machines. Alternatively, according to the European Vending Association, the capacity of these machines can be measured as the physical volume of the refrigerated space, excluding the volume dedicated to controls/payments and the volume dedicated to product delivery. This approach is detailed in the Energy Measurement

Protocol that has been published by the European Vending Association[6] and is the preferred approach for food/snack machines.

There are therefore potentially two quite different capacity related categorisations that may be required. This raises the potential necessity to differentiate between these two types of vending machine. It is proposed to consider dividing beverage vending machines into three size classes, small, medium and large, and snack/drink machines into small and large. The necessity for this will be decided once some analysis has been carried out to test the extent to which power is dependent upon capacity, and if necessary the thresholds of these categories will be decided at that stage.

- *Proposal: Further to the discussion under matrix row D) above, it is proposed to clearly differentiate between beverage (can & bottle) vending machines and snack/drink vending machines (including spiral vend and carousel). Capacity of a machine will be measured by the number of cans/bottles/food packets it can store. Capacity data will also be requested (especially for snack/drink machines) in the form of the volume of refrigerated space in litres (see Metrics section below). Products may be divided into three size categories for beverage only (small, medium and large) and two sizes (small and large) for snack/drink according to data obtained. Data will also be requested on the average size of the vended bottles/cans/packets in the national market where available.*

Matrix Row H): Location (indoor/outdoor)

Some vending machines are designed to be placed outside and fully weatherproof, others can only be used indoors. Its location will affect the energy consumption of the product, depending on by how much the average external ambient is higher or lower than the internal storage temperature. The ENERGY STAR criteria for vending machines require a different test temperature and humidity depending on whether the product is intended for indoor or outdoor use, but the same energy efficiency criteria apply regardless. Similarly, it is proposed to group indoor and outdoor products together for this analysis, but seek the data to enable comparison of performance of indoor and outdoor units in case this is significant.

- *Proposal: Data will be invited to distinguish vending machines intended for indoor or outdoor use, but it is intended to analyse both types together.*

Matrix Row I): Visibility of products to be sold

For the majority of beverage (can/bottle) vending machines, the contents are not visible from the outside, which is usually covered in illuminated advertising over the insulation. If the product is to be visible from the outside, glass is required which will restrict the amount of thermal isolation, and therefore the energy efficiency. For beverage vending, it makes no difference to functionality from the user's point of view as to whether the product is visible or not. For food/drink vending, visibility of the product could be important. Product visibility will be invited as a secondary characteristic.

- *Proposal: To invite data on whether machines allow visibility of the products as a secondary factor.*

Matrix Row J): Payment

Some vending machines can accept payment by cash, card or tokens. This should make no difference to their energy efficiency (energy consumption during vend is a negligible proportion of the total) and so no product differentiation is proposed in this respect.

- *Proposal: To ignore any difference in payment mechanisms between machines.*

[6] Test Protocol for the Measurement of Energy Consumption in Vending & Dispensing Machines, Version 2.0 – June 2008, European Vending Association, Brussels, http://www.vending-europe.eu.

3. Participating Country Requirements

No further requirements identified.

4. Metrics

Energy consumption and efficiency

The performance metrics generally used for these products are kWh per 24 hours (day) or average kW power over a year (multiply kW figure by 24 to get kWh/day). This is strictly speaking a consumption metric. Efficiency metrics are discussed below.

Energy consumption could be measured during the following operational modes:

- Normal idle mode, i.e. waiting for the next customer during normal operating hours. This is by far the most dominant mode and is considered typical of the annual performance.
- Vending mode is transitory during actual delivery of a sale. The actual vending operation is transient and infrequent when averaged over the whole year for machines that are mostly operational 24 hours per day, 364 days per year.
- Reloading and pulling down phase after refill. This is also a transitory phase and is ignored when characterising typical performance.
- Low-power mode, in which lighting and refrigeration may be off or running at a reduced level. The internal temperature may be allowed to rise.

The mode of most significance to this analysis is the normal idle mode, as used as the basis for the ENERGY STAR criteria and MEPS in Australia and Canada. Data is unlikely to be available for anything but normal idle mode, but could be invited also for low-power mode.

Two test methodologies have been identified:

1. ASHRAE Standard 32.1-2004, Methods of Testing for Rating Vending Machines for Bottled, Canned, and Other Sealed Beverages (as used by ENERGY STAR and US DOE MEPS[7])
2. Test Protocol for the Measurement of Energy Consumption in Vending & Dispensing Machines, Version 2.0 – June 2008, European Vending Association, Brussels, http://www.vending-europe.eu (as proposed by this manufacturers' association for use in presenting performance data to customers, and also for a voluntary energy labelling scheme in Europe[8]).

The ASHRAE test methodology has been adopted by the USA EPA for ENERGY STAR, California Energy Commission for state MEPS, Canada and Australia. The European Vending Association methodology has not been adopted by any national schemes, nor is there much public domain product performance information available that is based upon this methodology (based on UK study during 2009). Hence it is proposed to adopt the AHSRAE test methodology for this analysis. Should any significant datasets be identified using other methodologies, normalisation will have to be considered.

Energy efficiency metrics (i.e. specific consumption) are not generally used in the sector. However, for the purposes of this analysis and energy efficiency comparison, the following metrics will be used:

- Energy efficiency of beverage (can/bottle) vending machines in kWh per 300 cans per day. This uses the lowest likely capacity of machine (300 cans) as the baseline, with larger machines credited for their higher capacity.

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

[8] Only one manufacturer is known to have published product data using this voluntary label.

- Energy efficiency of snack/drink machines either in kWh per litre of refrigerated volume per day, or in kWh per 300 snack items per day, depending upon which capacity metric is available.

Capacity

Capacity of beverage (bottle/can) and snack/drink vending machines is generally measured in number of cans/bottles or packets of food/snack that the machine's carousel can store. For example a beverage machine may hold 650 cans. It is also preferable to determine the size of the bottle/can that can be accommodated – whether 355 ml (common in USA), 330 ml (Europe), 0.5 litre bottle or other as this could influence the overall size of the machine, and so it's refrigerated volume and heat losses etc.

Alternatively for some snack/drink vending machines capacity can be measured in litres of refrigerated storage space. The volume of space used for dispensing the product would not be included in this, nor would any volume associated with payments or product selection as per the European Vending Association energy measurement protocol[9].

It is proposed to invite capacity data in both of these formats – accepting what is available.

5. Data requirements

To enable the most effective analysis of data and comparison between countries, we would like to collect the data listed below:

- Black text indicates the main data requirements for this process.
- Blue text indicates data that is not necessary to undertake the mapping and benchmarking for this product but that will bring other benefits to the process and/or allow more detailed analysis at a later date.
- Where the data is not available in the format requested, ***italic text*** indicates alternative formats in which the data may be provided.

Information on new products on sale

For all years available between 1996 and 2010 and for all categories as defined in Table 3, ideally this will be in the form of **individual machine model information** including (in approximate order of priority)**:**

1. Product type: Whether refrigerated beverage vending machine (can/bottle), refrigerated food/drink vending machine of spiral type, refrigerated food/ drink machine of carousel type.
2. Product capacity, in maximum number of cans/bottles/food packets that the carousel can store,
3. The average size of can/bottle that can be accommodated (e.g. 0.33 litres, 0.5 litres etc).
4. The volume of the refrigerated storage space may be measured in litres. If available, please provide this as well as number of cans/packets to quantify capacity.
5. Power measured according to ASHRAE 32.1 measured in kWh per 24 hours. *Or if not available, power in normal idle mode in kW.*
6. Power in low energy mode (kWh/day) *or in kW*.
7. Typical storage temperature (in order to exclude frozen and ambient machines).
8. Where the product is intended for indoor or outdoor use, or both.
9. Whether the machine is glass fronted or closed.
10. Refrigerant type.
11. Foam blowing agent type.
12. Whether or not the machine is capable of automatically entering a low-power mode.
13. Whether or not the machine has usage sensor to trigger a low-power mode.

[9] See footnote 6.

14. Whether or not the machine has a timer to trigger a low-power mode.

Information on stock

For all years available between 1996 and 2010:

15. Total national stock of products in service (in thousands of products)
16. Typical Unit Energy Efficiency level (UEE), capacity (drinks/packages) and/or annual Unit Energy Consumption (UEC) in the stock,
17. Total annual consumption of all units in the stock.

Additional Information Required for Data Processing

18. Test methodology(ies) used to derive the data, and any relationship to known international standards (e.g. ASHRAE Standard 32.1-2004; clone of test method XYZ [with these amendments: A, B and C], etc.)
19. Dates at which any changes to test methods occurred
20. Indicative statistics on how national drinks sales through vending machines break down, particularly the ratio of cans (preferably of which size) compared to bottles (ditto for size). This is in order to provide at least qualitative analysis of comparability of typical vending machine type/size between countries.
21. List of local regulations that define and affect product efficiency
22. Total national annual sales (in thousands of products).

Additional Information Required for Other Planned Analysis

23. Summary of all major policy actions affecting refrigerated vending machines over the period data is available including whether voluntary or mandatory, the year when policy was first considered, the year of formal announcement of the policy plans, and the year when the policy came into force.
24. Summary of any major cultural or other issues that are thought to affect this product at the local level.