Electric Appliances

HIGHLIGHTS

■ **PROCESS AND TECHNOLOGY STATUS –** This brief deals with residential and commercial electric appliances other than space heating and cooling devices, water heaters, lighting, cold appliances, cooking devices, washing machines, dish washers and dryers, which are dealt with by ETSAP R02 to R09, respectively. Among remaining electric appliances, electric irons, coffee machines and vacuum cleaners are the most energy-consuming and significant products. In particular, the brief focuses on coffee machines and vacuum cleaners as currently available data on electric irons are insufficient for technology characterisation. Coffee machines are countertop appliances used to brew coffee. There are three main domestic models available on the market: automatic drip filters, single servers and espresso machines. Commercial models include coffee urns or large-capacity filter coffee machines, filter coffee machines with one or several integrated warmers, commercial espresso machines and small vending machines. In 2010 it was estimated that there were approximately 111 million units of non-commercial coffee machines on the EU-27 market, with drip filter coffee machines accounting for 53% of the market share. In the US, over the same time period, 24.6 million units were sold, with sales values of $1.1 billion. Automatic drip coffee machines made up 75% of the US market share of units sold in 2010; single serve and espresso machines made up 19% and 6% respectively. At present there is limited information on commercial models. All coffee machines function by passing water through ground coffee, although coffee can be inserted in different forms depending on the model type. Vacuum cleaners are used to remove dirt, dust and soil and used to create a cleaner, more hygienic environment. Models available on the market include: upright, canister, stick, wet-dry, wide-area and steam/deep cleaner vacuum cleaners. Each design incorporates a motor, separation system (bag/bagless system), filtration system, cleaning head and power source. In addition, some models also have a clean carpet sensor. In 2005, approximately 45 million vacuum cleaner units were purchased in Europe, of which the total annual expenditure for domestic vacuum cleaners (both canister and upright) in Europe was €4.7 billion; the commercial vacuum cleaner expenditure in Europe was € 325 million.

■ **PERFORMANCE AND COSTS –** The energy consumption of coffee machines, as with most electrical appliances, depends on a number of factors. These include power requirements in different operational settings (on-mode, off-mode, and standby-mode) and usage, which refers to the average time the appliance, is left in a particular operational mode. It is estimated that the total European coffee machine stock consumes approximately 17,000 million kWh per year; this has a resulting electricity cost of about € 2.5 billion. In the European market, the most expensive coffee machine available is a fully automatic model retailing at an average of € 595 per unit, and the cheapest, a drip filter, retails at an average of €35. Input power ranges can vary between 550 to 1500 Watts depending on the model. Vacuum cleaners have shown an increase of input wattage from approximately 400 Watts in 1978 to 2,700 Watts in 2008. The increase in input power is due to the use of more powerful electric motors. In Europe, 39% of the vacuum cleaners sold in 2007 were models with an input power of 1,800 Watts or above. The average base case price for domestic and commercial vacuum cleaners was € 110 and € 250 respectively. Other life cycle costs such as electricity running cost, vacuum cleaner bags, office paper (for filters, instruction manuals etc.) and repair and maintenance have been calculated as € 91, € 52, € 2 and € 8 respectively.

■ **POTENTIAL AND BARRIERS –** There are a number of barriers limiting the uptake of more efficient coffee machine and vacuum cleaner models including: cost, style/design of the product; inertia, convenience and lack of knowledge; and lack of consumer awareness. For coffee machines, water heating is the primary source of energy consumption, with small amounts also being used by motors for mechanical action, by the electronics and lost as heat. Manufacturers have targeted the active/ 'on' mode and the standby mode as areas for energy reduction in espresso machines, whilst in drip filter coffee machines, the components that keep the coffee hot have been targeted. Although coffee machines and vacuum cleaners fall under standards that address measurement and safety there are currently no European Union legislation specifically targeting the energy efficiency of each appliance. National energy performance testing standards that capture coffee machines exist in non-EU countries such as Australia, Brazil, Canada, Chile, China, Japan, Russia, and the United States A preparatory study has been launched with proposals that include an energy label of vacuum cleaners, under the Ecodesign Framework Directive 2010/30/EU. The European Union has also proposed a cap on the input power rating of vacuum cleaners; these range from 750 Watts for canister cleaners and uprights with integral hoses, to 1250 Watts for commercial vacuum cleaners with dual motors in 2014. Other areas targeted for improved efficiency are: input power, suction power, airflow, and nozzle design.

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PROCESS & TECHNOLOGY STATUS

This briefs brief deals with residential and commercial electrical appliances other than space heating and cooling devices, water heaters, lighting devices, cold appliances, cooking, washing machines, dish washers and dryers, which are dealt with by ETSAP Technology Briefs R02 to R09, respectively. Among remaining electric appliances, electric irons, coffee machines and vacuum cleaners are the most energy-consuming and significant products. The brief focuses in particular on coffee machines and vacuum cleaners as currently available data on electric irons are insufficient for technology characterisation. Coffee machines and vacuum cleaners are widely used in developed countries while in developing countries and regions they are not affordable for the majority of the population and very little information is available on their use.

■ **Coffee Machine Technology -** Coffee machines are countertop appliances used to brew coffee. For the purpose of this report, coffee machines with a built-in energy source (i.e. electricity) are discussed, which represent the majority of currently used devices; appliances reliant on an external energy supply (i.e. a stove top percolator) are not included. There are three main domestic coffee machine appliances: [1]

- ***Automatic drip filters*** function by percolating hot water (which is heated by electrical resistance) through a brew basket of coffee grounds. Coffee is captured in a decanter that may be heated by a warming plate. Coffee granules can be contained in insulated or non-insulated pods.
- ***Single servers*** **(**also known as a pad/pod filter machines) function by forcing a precise amount of hot water through a small container of coffee granules to make a single serving. They are typically pressurised by a pump to approximately 3 bars.
- ***Espresso machines*** function by forcing hot water through coffee granules at a pressure of approximately 15 bars. Gravity drives the fluid into a cup producing a coffee product called espresso. Espresso machines consist of pump- and steam-driven devices. They are available as automatic, semi-automatic and manual machines (with an independent electrical heat source). Fully automatic machines are capable of grinding, dose tamping, and brewing coffee, whereas semi-automatic machines allow the operator an element of control (during coffee extraction and steaming). Espresso machines often include auxiliary milk steaming and frothing functions. A combination espresso machine allows for brewing of both regular coffee and espresso.

The main components of a coffee machine vary according to the type of machine but can include: a heating element, a decanter/ carafe (drip filter models), a grinder (models that take coffee beans), a warming plate (drip filter models), a microprocessor, a boiler/ thermo-block, an electrical pump and a steam wand (models that provide milk frothing).

All coffee machines function by passing water through ground coffee. However, depending on the model type the coffee can be inserted in different forms, i.e. coffee beans (with grinding equipment) or the most popular ground coffee [1] which can be inserted directly into the coffee machine filter, or as individual capsules of aluminium and/or plastic or coffee pads.

Commercial coffee machines include: coffee urns or large-capacity filter coffee machines; filter coffee machines with one or several integrated warmers, commercial espresso machines and small vending machines [1]. There is limited information on these models at present in the market.

In 2010 it was estimated that domestic (non-commercial) coffee machines in use within the EU-27 region amounted to approximately 111 million units [6], with *drip filters* making up 53% of the market share. To put figures in a perspective, it is important to note that the global market of small electric household appliances is growing at a compound annual rate of 2.54%, and reached approximately 575.6 million units in 2010 [6]. After electric irons, coffee machines are the second largest segment of this market. In 2010, the small electric household appliances market in the Asia-Pacific region was estimated at approximately 174 million units [6]. Approximately 24.6 million units were sold in the US in 2010 which equated to $1.1 billion [5]. Automatic drip coffee machines made up 75% of the market share of units sold; in the US single servers and espresso machines made up 19% and 6% respectively. Euro-TopTen (an independent international program) estimated that the total European stock consumes approximately 17,000 million kWh per year; this has a resulting electricity cost of about € 2.5 billion [3].

■ **Vacuum Cleaners Technology-** Vacuum cleaners are used to remove dirt, dust and soil and to create a cleaner, more hygienic environment. Domestic appliances (those used in residential environment) are generally designed for usability, affordability and aesthetics. Commercial and industrial vacuum cleaners (the latter designed for specialised applications) are built to be easily maintained and durable; they are intended for professional housekeeping purposes, cleaning staff, contracted cleaners or laymen, and primarily used in offices, shops, hospitals and hotels for longer periods of time than household vacuum cleaners. [2].

The 2011 ENERGY STAR Scoping study [2] categorised the vacuum cleaners as follows:

- ***Upright Vacuum:*** self-contained units with motor, cleaning head, separation system, filtration system, and exhaust port built into a vertical stand-alone configuration.
- ***Canister Vacuum:*** separate cleaning head from the vacuum generator, and dirt storage compartment, normally with a flexible hose/wand connecting the body (which contains motor, separation and filtration system, and exhaust). This enables increased mobility without the loss of suction power or filtration.
- ***Stick Vacuum:*** similar to the upright vacuum, but lighter weight, with dirt storage and vacuum generator mounted on a central rigid handle joining the cleaning head. Dirt is removed from suction power only. This cleaner is used for smaller area.

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- ***Wet-Dry Vacuum:*** a “canister” body to store dirty water. It also includes motor, separation system, and long hose that connects to the cleaning head. It is used in garages and home workshops due to its capability to pick up wet debris, water and large quantities of dirt without clogging.
- ***Wide-area Vacuum:*** similar to the upright canister, with cleaning heads that cover larger areas.
- ***Steam cleaner/deep cleaner:*** using warm water and detergent sprayed onto a surface for cleaning, dirt is then extracted in solution via suction. The cleaning head includes spray system, suction port, and can often have an agitator/ brush to lift the dirt.

Additionally, vacuum cleaners use different filtration systems[1]. The system can vary between cloth, paper, artificial fibres, liquid, solid, and no barriers such as cyclones, electrostatic or combination filters. Some filters remove microscopic particulate matter and purify the exhaust air - a feature designed for people who are sensitive to dust or other allergens. Vacuum cleaner design has also seen a change in material from metal to plastic, allowing for a lighter, more manoeuvrable appliance [2].

The main manufactures on the European market are: Dyson, Vax[2], Electrolux, Hoover, Miele, Siemens, Rowenta and Philips. Additionally, brands from the Far East have produced products for the EU market, including LG, Panasonic and Samsung; own-brand products sold by retailers also have a part in the EU market [2].

Domestic vacuum cleaner ownership (i.e. total units and model type) varies across Europe; available datasets do not allow a full comparison of EU-27 countries. However, data show a substantial increase of vacuum cleaner ownership in the EU between 2000 and 2005. Imports and exports for most Member States approximately doubled in this period. In 2005, the uptake rate of vacuum cleaners was approximately 45 million units [11]. The increasing figures could result from a number of reasons - declining product lifetime[3], or an increase in the multiple-ownership of appliances. In 2006, the total sales of commercial vacuum cleaners across EU25 countries were approximately 1 million units (split as 70% vacuum cleaners, 30% wet/ dry vacuum cleaners) [11].

Approximately 575,000 commercial vacuum cleaners were sold in the US in 2008, with a projected annual growth rate of 2 to 5%. The majority of commercial sales are through retail distribution channels, though the Internet is the fastest-growing sales channel [2].

[1] Vacuum cleaners filter the dust and dirt from the airflow after picking up from the surface being cleaned. This prevents any dirt being blown back into the atmosphere after cleaning.
[2] Vax are part of TTI, the world’s largest vacuum cleaner manufacturer
[3] Falling lifetime is due to many reasons including premature replacement of vacuum cleaners by consumers who perceive their vacuum cleaner technology to be ‘out of date’.

PERFORMANCE & COSTS

■ **Coffee Machine Energy Efficiency** – The energy consumption of coffee machines, as with most electrical appliances, depends on a number of factors. This includes power requirements in different operational settings (on-mode, off-mode, and standby-mode) and usage, which indicates the average time an appliance is left in a particular operational mode. Depending on the user’s habits, each of these factors can vary considerably. Table 1 highlights the typical range of inputting power (in watts) to run each of the different coffee machine models.

The typical lifetime for coffee machines range from 6 years for drip filter coffee machines to 10 years for fully automatic espresso machines. The lifetime electricity consumption for drip filter and automatic espresso coffee machines are 1,030 kWh and 1,133 kWh, respectively [5]. The highest lifetime electricity consumers are the semi-automatic espresso machines that use approximately 1,367 kWh, whereas the lowest are the hard cap espresso machines consuming 843 kWh in their 7 year lifetime [5].

Conventional machines are the most popular models for comfort and quality reasons (i.e. the fully automatic/ portion capsules machines). However they account for the largest energy losses as they have to maintain a boiler/ thermo-block temperature between 85 – 90°C in ready/’on’ mode [3]. Sustaining this temperature can consume up to 170 kWh per unit per year[4]. If the appliance was never switched off, the consumption would be doubled [3]. Notable key parameters that strongly enhance the energy efficiency of coffee machines are auto-power-down, better insulation of hot components, reduction of the thermal capacity of the heating unit, “energy saving mode”, reduced or zero standby consumption, and lower amounts of water to be heated for hygienic and quality purposes [3].

■ **Vacuum Cleaners Energy Efficiency** - With the technology development, vacuum cleaner design has seen a dramatic increase in power demand and consumption since 1970. As electric motors are enhanced, so is the input power range; vacuum cleaners have undergone an increase of input wattage from approximately 400 Watts in 1978 to 2,700 Watts in 2008 (e.g. a bagless cylinder vacuum cleaner) [11]. Figure 1 highlights the increasing input power trend in recent years. In Europe, 39% of the vacuum cleaner sales in 2007 were of models with an input power of 1,800 Watts or above [11].

Both domestic and commercial vacuum cleaners have a lifetime of approximately 8 years (5 years for battery/cordless vacuum cleaners) with an estimated energy consumption per hour of use of 1.5 kWh and 1.1 kWh for domestic and commercial cleaners, respectively [11]. The MEEuP study on vacuum cleaners in the Netherlands [4] suggests an average of 70 minutes per week (or 60 hours per year) is spent using vacuum cleaners in a domestic environment.

[4] This is dependent on the consumers’ usage habits/ switching off practice.

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An EU study stated an annual use of 62.5 and 187.5 hours for domestic and commercial vacuum cleaners, respectively [11].

■ **Coffee Machine Prices/Costs -** In the European market, the most expensive coffee machine available is a fully automatic model retailing at an average of € 595 per unit [6]; Semi-automatic espresso coffee machine averaged at € 103 per unit. The cheapest model is the drip filter machine retailing at an average of € 35 per unit [6]. Table 2 highlights the typical prices for coffee machine in the US.

■ **Vacuum Cleaner Prices/Costs -** The total annual expenditure in 2005 on domestic vacuum cleaners (both canister and upright) in Europe was €4.7 billion; the commercial vacuum cleaner expenditure was €325 million. An average base case price for domestic and commercial vacuum cleaners per unit was € 110 and € 250, respectively [11]. The cost of electricity consumed by each model per lifetime (8 years) is approximately € 91 and € 200 for domestic and commercial vacuum cleaners respectively [11]. Table 3 highlights the price ranges of vacuum cleaners in the US. In 2010, the total annual sales of domestic vacuum cleaners was $2.6 billion - upright, canister, stick and stream vacuum cleaners represented 78%, 8%, 5% and 9 % respectively of the total US market share.

Table 1 – Input Power Ranges for Coffee Machine [2]

Product Type	Type	Input power (W)
Automatic Drip Filter	Small Capacity (4/5 cup)	550-900
Automatic Drip Filter	Full Size (10/12 cup)	750-1200
Single-Serve Coffee Maker	Capsule	900-1500
Espresso Machine	Pump & Fully Automatic	1000-1500
Espresso Machine	Steam	600-800

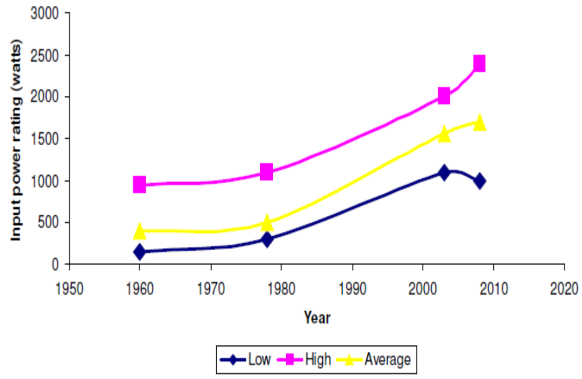

Figure 1 - Increase of Vacuum Cleaners Input Power over the past decades [11]

Table 2 - US Price Range for Coffee Machines [8]

Model	Price range ($)	Average price ($)
Automatic drip, small capacity	12-54	33
Automatic drip, full capacity	18-100	59
Automatic drip, thermal carafe	46-147	97
Pod/ Capsule	14-100	57
Espresso (pump)	57-103	80
Espresso (steam)	35-770	56
Automatic drip, small capacity	12-54	33
Exchange rate: 1 Euro = US $ 1.3 (May 2012)		

Table 3 - US Price Range for Vacuum Cleaners [8]

Product	Residential Devices (€)	Commercial Devices (€)
Upright	49-772	77-770
Canister	39-1,000	230-1,240
Stick	23-230	n/a
Wet/Dry	39-540	39-1,080
Steam	77-310	150-2,700
Exchange rate: 1 Euro = US $ 1.3 (May 2012)		

POTENTIAL AND BARRIERS

■ **Coffee Machines -** There are a number of barriers limiting the uptake of more efficient coffee machine models. These include consumer buying decisions, developments in eco-design and consumer awareness [7]. Consumers tend to purchase coffee machines and use them for the lifetime of the product. New machines are usually only purchased when an old appliance breaks. This would suggest that newer, more innovative technologies are only incorporated into the household when the old appliance needs to be replaced. It therefore takes time for energy efficient appliances to penetrate the market [7]. Main barriers that restrict the uptake of efficient models are as follows [7]:

- ***Cost*** – More efficient/ innovative technologies are more expensive; consumers tend to opt for cheaper, less efficient models, and are rarely aware of the energy used by coffee machines during their lifetime
- ***Style/Fashion*** – Design/aesthetics are important to consumers. There has been a greater uptake of drip filters than espresso machines [7].
- ***Convenience*** – Consumers want an easy access to products; the use of power management or shutting off the appliance can be too time consuming for users.
- ***Lack of knowledge*** – Relevant information is not readily available to consumers; few are aware of power management functions, or the improved technology/performance of certain models.

Overall, the main barrier facing the uptake of efficient coffee machines is the relationship between eco-design, high performance and cost. There is however a vast potential for improvement and cost saving. Water heating is the primary source of energy consumption in a coffee machine, with small amounts being used for motor energy for mechanical action, for electronics and heat losses. For espresso machines, manufacturers

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have targeted the active/ 'on' mode and the standby mode as areas for energy reduction; whilst in drip filter coffee machines, the components that keep the coffee hot have been targeted [8].

Most drip filter coffee machines are programmed with an auto power down in the range of 20 minutes to 4 hours (mainly for safety). Higher-end programmable models allow consumers to adjust the auto-power down settings (although full awareness of these functionalities is low among consumers) [8]. In the US, approximately half of households use the warming plate for over 30 minutes, with nearly a quarter of households using it for over an hour to heat carafes with brewed coffee [9]. Developing an auto-power down function after 60 minutes of the appliance being switched on could lead to potential energy savings of 14%; similarly, an auto-power down of 30 minutes following brewing completion (warming plates) can have potential energy saving of 23%. [8]

In espresso machines, the greatest amount of electricity is consumed for heating purposes (maintaining water temperature) in ready-to-use mode according to studies carried out by the Swiss Agency for Efficient Energy Use (SAFE) [10]. Switching off an espresso machine at night can save up to 6 times the electricity required to maintain the water temperature [8]. The function is especially important for coffee machines that are used in office settings, as they are seldom, if ever, manually switched off [8].

While many machines are already equipped with an auto-power down function, savings can be achieved by reducing factory-set time lags and enabling machines with effective consumer programming options [8]. Other potential energy saving improvements includes:

- ***Insulation:*** this would decrease the thermal heat losses, thus decreasing the energy required to maintain a certain water temperature. For espresso/pod machines, a potential 5% saving can be made (when machine is in 'on' mode). For drip filter machines, the jig/ carafe would require insulation; this could lead to potential energy savings of up to 15%.
- ***Flow through water heaters*** *(single serve and espresso machines):* they activate just before coffee production begins, and only heat the require amount of water. Flow-through heaters are the most efficient water heaters for coffee machines available today. This technology can achieve significant energy savings in pod/ single-serve and espresso machines with little to no functional and design constraints. Potential energy savings of 50% and 30% can be made for single/pod and espresso coffee machines, respectively.
- ***Standby:*** potential energy efficiency savings of 3-5% are achievable through zero watt standby capability.

In the US, it is estimated that a domestic espresso machine can have a unit energy saving of 7 kWh per year, and up to 25 kWh per year for a drip filter machine. These energy savings could lead to potential lifetime cost savings of $7-21[5] [8].

[5] Savings depend on coffee machine type (assuming 7-year lifetime).

Table 4 – Percentage Energy Saving Potential for Auto-Power Down of coffee machines [8]

Product type	5-min	30-min	60-min
Pod	34.1%	18.2%	7.5%
Hard cap espresso	24.4%	13.4%	5.5%
Semi-automatic espresso	18.4%	11.3%	6%
Fully automatic espresso	27.6%	15.5%	6.9%

Notes: This table highlights the potential energy savings from having a pod or espresso machine set to switch off automatically after a certain period of inactivity, reducing the amount of time spent in ready-to-use mode per coffee period, and thereby reducing energy consumption.

The national annual energy savings opportunity is estimated to be on the order of 124,000 MWh which equates to a CO_2 reduction of approximately 86 kton CO_2 [6] [8].

There are currently no directives/standards at European Level (CEN) for coffee machines performance [1], and no European countries regulate the energy efficiency of coffee machines. However, coffee machines fall under standards that address measurement standards and safety, such as [1]:

- ***Environmental legislation****:* Waste Electrical and Electronic Equipment Directive, Restriction of the use of certain Hazardous Substances in electric and electronic equipment Directive, REACH Regulation No 1907/2006
- ***Energy legislation***: Commission Regulation (EC) No 1275/2008 of 17 December 2008
- ***Safety related legislation***: Low Voltage Directive (LVD) Commission Regulation (EC), General Product Safety Directive, Materials and articles intended to come into contact with foodstuffs Directive, Electromagnetic Compatibility (EMC) Directive

Appliances can also be captured in other international standards. National energy performance testing standards that capture coffee machines also exist in non-EU countries such as Australia, Brazil, Canada, Chile, China, Japan, Russia, and the United States [1].

■ **Vacuum Cleaners -** There is substantial room for energy efficiency improvements to current vacuum cleaner technology. The UK has a voluntary product certification and labelling scheme called the 'Energy Saving Trust Recommended', which has recently finalised criteria for assessing vacuum cleaners. In order to receive certification, both upright and canister vacuums must have input power of less than or equal to 1200 W[7] [2]. The model must comply with minimum safety standards and 500 hours of usage, as demonstrated by test data, or a 5 year guarantee offered to consumers. [2]

[6] This study is based on 2010 retail sale figures in the US, and assumes that 25% of products sold were replaced with energy efficient coffee machine models. Figure originally reported as 190 million lbs CO_2 and converted to tonnes assuming 2.20462 lb. to 1 kg. Emission factor 1.54 lbs. CO_2 per kWh was used in the original report.

[7] Whilst meeting minimum cleaning hard floor and carpet performance measured at full load using EN 60312

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There is currently no European Union legislation specifically targeting the energy efficiency of vacuum cleaners. A preparatory study has been launched with proposals that include an energy label of vacuum cleaners, under the Ecodesign Framework Directive 2010/30/EU[8] [2]. The label would apply to "normal" vacuum cleaners intended for domestic use and similar cleaning likely making no distinction between canister, stick, and upright models [2]. The European Union has also proposed a cap on the input power rating of vacuum cleaners; these range from 750 Watts for canister cleaners and uprights with integral hoses, and 1250 Watts for commercial vacuums with dual motors in 2014.

Government-enforced caps will force manufactures to redesign their appliances and utilise energy efficient technology. Potential areas of inefficiencies to be targeted are [2]:

- ***Input power***: there is a minimal correlation between power and cleaning performance. There is a lower limit below which no cleaning performance would occur at all, then a small band of rapid improvement, followed by a wider band of small or negligible improvement. The cleaning head design, brush mechanisms and a sealed system are often more important factors for cleaning performance than input power.
- ***Suction Power***: electrical power is converted to mechanical power (i.e. suction with air flow) in the suction motor. Improving the efficiency and capacity of this motor will enhance cleaning power; energy losses are between 60% and 70% in current designs which mainly manifest as heat via the exhaust air. With application of best available technology, a target energy loss of 45% is achievable through improvements in design to the fan case and fan blades.
- ***Airflow*: ** Currently the energy losses due to the airways are at best 5% and at worst 10%. Best available technology suggests that energy loss of around 5% is the achievable target.
- ***Nozzle design***: With efficient nozzle design, a target energy loss of 10% is achievable.

Energy losses in vacuum cleaners range between 75% and 89%. Enhancing the design process and ensuring all vacuum cleaners incorporate energy efficient technology could reduce the energy loss to 60%.

The US ENERGY STAR scoping study (2011) [2] estimated a per-unit annual savings for residential vacuums could be in the range of 10 to 19 kWh per year, resulting in a 7 year lifetime saving of $7 to $15. In the US, this could lead to a national saving opportunity of approximately 67,000-135,000 MWh per year if 25% of products sold were replaced with energy efficient models. [9] [2]

Commercial vacuum cleaners can provide significantly greater unit savings, $46 to $91 over a 2.5 year lifetime of the product, due to their increased frequency of operation. There national energy savings would be in the order of 24,000 to 48,000 MWh per year (less than residential cleaners due to the smaller market).

Efficient domestic and commercial vacuum cleaners face similar barriers to coffee machines, i.e. consumer awareness and buying decisions for technologically enhanced models.

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[8] The energy labels would be based on the energy consumption and cleaning performance of the vacuum cleaner, with possible minimum limits set for noise and dust re-emissions.

[9] Savings based on an approximate market of 28 million units sold each year, and a high usage rate.

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Summary Data Tables for Coffee Machines and Vacuum Cleaners

Table 5 - Key Technological and Efficiency Data on Vacuum Cleaners

Percentage of Vacuum Cleaner Sales rated over 1800 Watts in Europe [4] [11]	2003	2004	2005	2006	2007
>1800 W	18%	14%	18%	28%	39%
Main environmental impacts of EU-Stock (2005) [11]	Domestic Canister	Commercial Canister	Domestic Upright	Commercial Upright	Battery/Cordless
Total Energy (Gross Energy Requirement - GER) [PJ]	315.92	21.28	55.30	3.73	7.52
of which, electricity * [TWh]	26.32	1.85	4.64	0.33	0.56
Water (process) * [mln.m^3]	28.88	2.03	5.08	0.36	0.76
Waste, non-hazardous/ landfill* [kton]	803.35	64.69	118.94	6.30	23.06
Waste, hazardous/ incinerated* [kton]	71.80	2.96	11.91	0.51	2.92
Emissions (Air)					
Greenhouse Gases in GWP100 [mt CO_2eq]	14.28	0.95	2.50	0.17	0.35
*=caution: low accuracy for production phase					
Use phase technology Variants for Europe [11]	Domestic Canister	Commercial Canister	Domestic Upright	Commercial Upright	Battery/Cordless
Lifetime (years) per unit	8	8	8	8	5
Electricity consumption per hour per unit (kWh)	1.5	1.1	1.5	1.1	0.024
No. hours per year in use per unit	62.5	187.5	62.5	187.5	832
Standby electricity use per hour (kWh) per unit	0	0	0	0	0.00082
No. of hours per year at standby per unit	0	0	0	0	7,900
European Stock and Sales Estimates from Stock Modelling (2005) [11]					
% Share canister: upright	85%	85%	15%	15%	n/a
Stock (units) (2005)	274,000,000	8,840,000	48,300,000	1,560,000	10,000,000
Annual Sales (units) (2005)	36,500,000	1,105,000	6,450,000	195,000	2,000,000
	Germany	Italy	United Kingdom	EU25 Totals	EU27 Totals
Domestic Vacuum Cleaners Production (000 units) ex PRODCOM (2006) [2]	5,310	2,500	1,830	195	14,000
Imports of Domestic Vacuum Cleaners (000 units) ex PRODCOM (2005) [2]	11,700	5,020	9,000	54,100	54,500
Exports of Domestic Vacuum Cleaners (000 units) ex PRODCOM (2005) [2]	6,720	1,720	651	22,400	22,400
Apparent Consumption of Domestic Vacuum Cleaners (000 units) ex PRODCOM (2005) [2]	No data	No data	No data	44,900	No data
Sales of Non-Domestic Vacuum Cleaners (2006) [11] (a) Vacuum cleaners (b) Wet/dry vacuum cleaners	230,000 (a) 90,000 (b)	20,000 (a) 10,000 (b)	1,000,000 [12]	700,000 (a) 300,000 (b)	1,300,000
UK Input power range [11]	2003 (Watts)		2008 (Watts)		
Bagged upright cleaners	1300 to 1800		1300 to 1800		
Bagless upright cleaners	1450 to 1700		1450 to 1700		
Bagged cylinders	1100 to 1800		1100 to 1800		
Bagless cylinders	1400 to 2000		1400 to 2000		

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Table 6 – International Costs for Vacuum Cleaners

Costs	Typical current international values and ranges	
US product price ranges [2]	Residential Price (Euro) [x]	Commercial Price (Euro)
Upright	49-772	77-770
Canister	39-1,000	230-1,240
Stick	23-230	n/a
Wet/Dry	39-540	39-1,080
Steam	77-310	150-2,700
Exchange rate: 1 Euro = US $ 1.3 (May 2012)		

[x] The upper end of the cost range for residential vacuums represents units sold door-to-door and via specialty retailers.

Base Case life cycle costs per unit - Europe [11] [+]	Canister/Upright – Domestic	Canister / Upright - Commercial	Battery/ cordless
Product price (€)	110	250	110
Electricity (€)	91	200	17
Aux. 1: Vacuum cl. Bags (€)	52	155	35
Aux. 2: Office paper (~ filters, instruction manuals etc.) (€)	2	2	2
Repair & maintenance costs (€)	8	40	8

[+] Base case costs model calculations used the following factors: A typical lifespan of 8 years, the total consumed energy, electricity rate of 0.15 euro/kWh, vacuum cleaner bags and filter costs both costed at 10 euro/kg and a discount rate (interest minus inflation) of 5%. The analysis has assumed all vacuum cleaners are of the disposable bag type. Bagless vacuum cleaners avoid the life cycle costs for bags consumed during the life cycle of the product.

Total Annual Consumer Expenditure - Europe 2005 [11]	Canister - Domestic	Canister - Commercial	Upright – Domestic	Upright – Commercial	Battery/ cordless
Product price (million €)	4,020	276	709	49	220
Electricity (million €)	3,850	273	679	48	40
Aux. 1: Vacuum cl. Bags (million €)	2,190	212	386	37	80
Aux. 2: Office paper (~ filters, instruction manuals etc.) (million €)	96	3	14	0	4
Repair & maintenance costs (million €)	342	55	60	10	20

U.S. Retail Sales of Vacuums – 2010 [2]	Canister	Upright	Stick	Stream
Retail Dollar sales (million Euros)	~154	1,575	108	185
Market Share by Retail Dollar Sales (%)	8	78	5	9
Retail Unit Sales (millions)	~2	19.3	3.5	3.3
Market Share by Retail Unit Sales (%)	7	69	12	12
Exchange rate: 1 Euro = US $ 1.3 (May 2012)				

European sales	Domestic vacuum cleaners with self-contained electric motor for a voltage >= 110V (Product ref: 29712113)	Domestic vacuum cleaners with self-contained electric motor for a voltage < 110V (Product ref: 29712115)	Total
Total Value of Production (million Euros) (2006) [11]	1,250	16	1,270
Average EU27 unit values (Euros) (2006) [11]	102	80	n/a

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Table 7 – Proposed Caps for Vacuum Cleaners under the European Eco-design Framework Directive 2010/30/EU

European Union Proposed Caps for Input Power Rating of Vacuum Cleaners [2]	2011	2014
Uprights without integral hose and tools	750 W	500 W
Canister Cleaners and Uprights with integral hose and tools	1,100 W	750 W
Commercial Vacuums with single motors	1,200 W	1000 W
Commercial Vacuums with dual motors	1,500 W	1250 W

Table 8 - Electricity Consumption of Coffee Machines

Electricity consumption of the Base-Cases in Europe, 2011 [5]	Drip filter coffee machine	Pad filter coffee machine	Hard cap espresso machine	Semi-automatic espresso machine	Fully automatic espresso machine
Electricity consumption during coffee period[∞] (Wh)	232	93	73	83	62
Yearly electricity consumption due to coffee periods (kWh)	169	102	80	91	68
Ready-to-use mode (W)	0.5	15	10	26	11
Yearly electricity consumption due to Ready mode (kWh)	2.4	60	40	104	45
Total yearly consumption (kWh)	172	162	120	195	113
Lifetime (years)	6	7	7	7	10
Lifetime electricity consumption (kWh)	1,030	1,134	843	1,367	1,133
[∞] Coffee period: the length of time to produce a cup of coffee, and the energy consumed for the entire process. [7]					

Table 9 - Key Technological and Efficiency Data for Coffee Machines

Coffee Maker Input Power Rating Ranges (Europe) [8]	Type	Input Power Rating
Automatic Drip Filter	Small Capacity (4/5 cup)	550-900 W
Automatic Drip Filter	Full Size (10/12 cup)	750-1,200 W
Single-Serve Coffee Maker	Capsule	900-1,500 W
Espresso Machine	Pump & Fully Automatic	1,000-1,500 W
Espresso Machine	Steam	600-800 W
Estimated household annual energy use and saving opportunities (Europe) [8]	**Estimates household annual energy use (kWh)**	**Estimates saving potential**
Drip filter coffee maker (full 10/12 cup)	100-150	20%
Single-serve coffee maker	45-65	40%
Espresso machine (pump & fully automatic)	30-50	25%
Espresso machine (steam)	10-30	35%
The estimated unit energy savings for more efficient residential coffee machines range from about 7 kWh/year (for an espresso machine), up to about 25 kWh/year (for a drip filter coffee maker), which would offer lifetime savings of $7-21, depending on coffee maker type, over an assumed 7-year lifetime.		

Table 10 – European Usage Figures for Coffee Machines

Coffee Machine Frequency of Use [8]	Twice per day	Once per day	2-3 times per week	Once per week	2-3 times per month	Once per month	Once every 2-3 months	Once every six months
Automatic Drip	19%	48%	15%	4%	5%	4%	3%	1%
Pod	16%	32%	26%	9%	6%	2%	5%	2%
Espresso	9%	18%	17%	13%	12%	9%	17%	3%

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Table 11 – International Sales and Costs Figures for Coffee Machines

U.S. Retail Unit Sales of Coffee Machines (in millions) – 2006-2010 [8]	2006	2007	2008	2009	2010	2009-2010 Compound Growth Rate
Automatic Drip	19	19	19	19	19	-1.2%
Single-Serve	1	2	2	2	4	36.0%
Espresso	1	1	1	1	1	6.2%

GFK Sales data for espresso machines (Australia) [13]	2000	2001	2002
Pump pressured units	14,000	22,000	62,000
Steam Pressured units	21,000	17,000	16,000
Unidentified units	2,000	29,000	59,000

Production, trade and consumption of electric coffee and tea machines in 2007, in units [6]					
	Germany	Italy	United Kingdom	EU25 Totals	EU27 Totals
Production (Quantity)	2,450,000	1,56,000	0	7,360,000	7,360,000
Imports (Quantity)	10,100,000	3,150,000	1,990,000	22,500,000	22,700,000
Exports (Quantity)	4,220,007	277,000	216,000	2,480,000	2,200,000
Apparent Consumption (Quantity) [Prod +Imp – Exp]	8,350,000	1,930,000	1,770,000	27,300,000	27,900,000

Production, trade and consumption of electric coffee and tea machines in 2007, in Euros [6]					
	Germany	Italy	United Kingdom	EU25 Totals	EU27 Totals
Production (Euros)	48,200,000	162,000,000	***	-	369,000,000
Imports (Euros)	430,000,000	91,300,000	52,600,000	564,000,000	564,000,000
Exports (Euros)	210,000,000	344,000,000	5,190,000	191,000,000	182,000,000
Apparent Consumption (Euros) [Prod +Imp – Exp]	269,000,000	-90,200,000	47,000,000	373,000,000	750,000,000
*** Data for this item is confidential and has been suppressed					

U.S. Retail Sales of Coffee Machines – 2010 [8]	Automatic drip	Single server	Espresso
Retail Dollar Sales (millions) Euros	371	390	105
Market share by retail dollar sales (%)	43	45	12
Retail Unit Sales (millions)	18.5	4.7	1.4
Market Share by unit sales (%)	75	19	6
Exchange rate: 1$ = 0.77 Euro (May 2012)			

U.S. Price Range by Product [8]	Price range (Euros)	Average (Euros)
Automatic drip (small capacity)	12-54	33
Automatic drip (full capacity)	18-100	59
Automatic drip (thermal carafe)	46-147	97
Pod/ Capsule	14-100	57
Espresso (pump)	57-103	80
Espresso (steam)	35-770	56
Exchange rate: 1$ = 0.77 Euro (May 2012)		

Average prices for coffee machines (EU) [6]	Average Price (euros)
Drip filter coffee machine	35
Pad filter coffee machine	81
Hard cap espresso coffee machine	156
Semi-automatic espresso coffee machine	103
Fully automatic coffee machine	595

Stock data [6]	Typical coffee machine product lifetime (years)	EU-27 –Estimated stock of non-tertiary coffee machines 2010-
Drip filter coffee machine	6	58,800,000
Pad filter coffee machine	7	22,700,000
Hard cap espresso coffee machine	7	12,500,000
Semi-automatic espresso coffee machine	7	9,010,000
Fully automatic espresso coffee machine	10	7,620,000

Table 12 – Potential Energy Saving Figures for Coffee Machines

Energy Saving Potential (%) for auto-power down in coffee machines [8]	5-min auto power down	30-min auto power down	60-min auto power down
Pod	34.1	18.2	7.5
Hard cap espresso	24.4	13.4	5.5
Semi-automatic espresso	18.4	11.3	6
Fully automatic espresso	27.6	15.6	6.9

Initial Estimates of Energy Savings Potential for coffee machines [8] **			
Drip Filter	Single-Server	Semi-automatic Espresso	Fully Automatic Espresso
15% to 24 %	35% to 51%	19% to 36%	28% to 42%

** The overall efficiency potential of each type of coffee machine is based on various scenarios incorporating one or more of the following improvement options: Insulation, Flow-through water heaters and Standby.
Scenarios based on European base case example.

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