

Strategies to Enhance Energy Efficiency of Coffee Machines

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Abstract

Coffee machines use large amounts of electricity for permanent ready (keeping hot) and standby modes. With relatively simple measures as auto-power-down, better insulation of boilers and low standby the energy efficiency can be strongly enhanced. The energy saving potential of an efficient versus a typical espresso machine is about 120 kWh per year. High efficiency coffee machines only have a consumption of about 50 kWh per year, capsule machines even below 40 kWh. The entire EU stock of coffee machines (estimated 100 Mio) thus holds a saving potential of up to 12'000 Mio kWh per year.

Conventional espresso machines usually have higher electricity consumption than A-class ovens or A++ refrigerators. Regarding the great differences between products and the high saving potentials, it is strongly recommended to take measures.

In the framework of the IEE-project "Euro-Topten" a measuring method for coffee machines was developed. The Blue Angel (der Blaue Engel) now follows a new cluster approach. As part of this approach it has launched a climate protection label (Klimaschutzzeichen). Thereby Euro-Topten and the Blue Angel coordinated their procedure and harmonized the measurement method. The criteria are applied for the label the Blue Angel and for the selection of best products of Europe on www.topten.info. The Euro-Topten measuring method is suggested for a labeling directive and might be incorporated into the IEC 60661 standard (Methods for measuring the performance of electric household coffee makers), respectively.

Particularly an EU-energy label for coffee machines and an appropriate application of the new European MEPS for standby (including auto-power-down) would be very effective measures to raise the efficiency of coffee machines, which should be covered by the preparatory study for ecodesign on coffee machines, Lot 25.

Already today, diverse high efficiency models of several important brands of coffee machines are available on the European market. They are presented on www.topten.info and – from June 2009 – can be labeled with the Blue Angel. An EU-energy label would be appropriate and would give important incentives to trade and industry to develop and offer more energy-efficient coffee machines.

European Market Situation of Coffee Machines

According to GfK more than 18 million coffee machines are sold in Europe every year, thereof 10 million traditional filter coffee machines and 8 million espresso and filter-pad machines (see table 1).

Sales coffee machines 2006/2007

Sales coffee machines (in 1000)	2006	2007	Increase
Filter	10'076	10'072	0.0%
Filter-pad	3'546	3'410	-3.8%
Espresso portioned	1'647	2'356	43.1%
Espresso fully automatic	824	870	5.5%
Espresso piston hand-operated	1'358	1'246	-8.2%
Combi Espresso-Filter	312	284	-8.9%
All Coffee Machines	17'763	18'238	2.7%
All Espresso- and Pad-Machines	7'375	7'882	6.9%

Table 1: Total sales figures of coffee machines of 18 European countries (AT, BE, CH, DE, FR, GB, ES, IT, NL, PT, SE, DK, FI, GR, PL, HU, CR and SR) according to GfK [1]

Traditional filter coffee machines still have the highest market share (55%). For comfort and quality reasons there is a strong trend towards espresso fully automatic and an extremely strong trend towards espresso portioned machines. Low-comfort and low quality machines such as filter-pad machines, espresso piston hand-operated and combi espresso-filter are losing market share. The (most energy relevant) espresso machines and filter-pad machines have a market share of 43% and a considerable growth of 6.9% (table 1).

However, according to private communications from producers it is known that national markets differ strongly. In some countries such as Italy, Switzerland or Portugal espresso machines have a huge market share of over 70%, while in other countries the share of espresso machines is still below 20% (e.g. Belgium, Germany or the Netherlands). In Belgium or the Netherlands filter-pads are quite popular with a market share of about 40%.

Furthermore it is interesting to have a look at the monetary value distribution of the markets. Because espresso machines are more expensive than filter-pad machines and especially filter coffee machines the impression is quite opposite to that of mere units: espresso machines (espresso portioned, fully automatic, piston hand-operated) are strongly dominating the market in value.

High Energy Saving Potentials of Coffee Machines

Coffee machines account for a significant proportion of the electricity consumption in more and more European households and offices. Most conventional coffee machines account for higher electricity consumption than A-class ovens or A++ refrigerators.

According to the research project "Standby consumption of household appliances" by the Swiss Agency for Efficient Energy Use (S.A.F.E.), Espresso and filter-pad machines use large (unnecessary) amounts of electricity for permanent ready (keeping hot) and standby modes [2]. According to measurements and tests by Topten [3], energy consumption of a typical espresso machine is about 170 kWh per year. With relatively simple measures as auto-power-down (auto-off), better insulation of boilers and low standby the energy efficiency of coffee machines can be strongly enhanced. High efficiency espresso machines only have a consumption of about 50 kWh per year, capsule machines even below 40 kWh. The magnitude of the energy saving potential of an efficient versus a typical espresso machine is about 120 kWh per year.

The stock of coffee machines in the EU is estimated 100 Mio units, consuming 17'000 Mio kWh per year and causing electricity costs of about 2'500 Mio Euro. Roughly 20 Mio coffee machines are sold per year. If in the next years these 100 Mio coffee machines in Europe could be replaced by energy-

efficient models, 12'000 Mio kWh or 1'800 Mio Euro electricity costs could be saved yearly. Appropriate technologies for high efficiency exist and have been introduced on the market. According to Topten a number of high efficiency models of several important brands of coffee machines are available on the European market (see www.topten.info) [4].

The Blue Angel

The Blue Angel is the world's oldest and most well-known eco-label. The German Federal Environment Ministry, the German Federal Environment Agency and the Environmental Label Jury decided to increasingly focus the Blue Angel on climate protection: From the beginning of 2009 the Blue Angel will also award to particularly energy-efficient and climate-friendly products and services. This is an important attribution for climate protection [5], [6].

The new climate label advises consumers which products are particularly energy-efficient and climate-friendly. To enable consumers to spot the best products more easily the new Blue Angel logo will provide corresponding additional information to visibly express this message in the logo itself.



The Blue Angel – A Climate Protection Label

The new label will, for a start, be available for ten product groups in a first phase, and further 90 product groups in phase 2 (2009–2012). The first new Blue Angel were passed by the Environmental Label Jury in April 2009 in Berlin, one of them being espresso machines.

The requirements for espresso machines (RAL-UZ 136) were elaborated by Oeko-Institute (Freiburg, Germany) [7]. The energy-relevant award criteria for coffee machines were developed by Euro-Topten.

Topten

Topten is a voluntary, non-profit international project to create a dynamic benchmark for the most energy-efficient products on national markets and to work in partnership with market actors to stimulate market demand for the highest-efficiency devices. The successful concept was first started in Switzerland (www.topten.ch) and Germany (www.ecotopten.de) in 2000.

Topten is a transparent system to continuously identify the best products available in each product category, with energy efficiency a key criterion. Topten makes the regularly updated results freely accessible via a user-friendly Internet interface. To each product category, selection criteria and comprehensive recommendations are available.

Topten is coordinated by the Topten International Group TIG (Paris, France).

“Euro-Topten” is a project supported by the European Commission Intelligent Energy – Europe IEE and national funding. So far, Topten is online in 12 European countries. Until 2010 it will be expanded to 16 European countries and include 20 partners (budget: 1.7 million €).

For coffee machines Topten has developed:

- Measuring Method and Calculation Formula for the Electricity Consumption of Coffee Machines for household use
- Criteria for energy-efficient Coffee Machines
- Recommendations for policy design

Euro-Topten Measuring Method and Calculation Formula for the Electricity Consumption of Coffee Machines

In the framework of Topten, the IEE-project “Euro-Topten” and the Swiss Agency for Efficient Energy Use (S.A.F.E.) have developed a measuring method to identify the energy consumption for the typical use of a coffee machine.

A first version of the Euro-Topten “Measuring Method and Calculation Formula for the Electricity Consumption of Coffee Machines for household use” [8] was developed within the scope of a Swiss research project and presented at EEDAL conferences in Torino 2003 [9] and in London 2006 [10]. Since then the method has been optimized and harmonized with the Blue Angel. As an essential advancement it is now possible to consider the effective time lag of auto-power-down according to actual factory settings instead of using a fixed value of one hour.

It is of prime importance to choose appropriate measurement methods. The experiences of Topten over several years indicated that key features as auto-power-down with short preset delay and insulated boilers have to be included carefully. On the other hand, effects as energy consumption for producing coffee or vapor, which look important at a first glance showed to be of little relevance but would cause measurement methods to become unreasonably complex and ineffectual in praxis. The production of coffee and vapor is not measured, but is accounted for with a standard value, as it requires relatively little energy and the difference from one machine to another is minimal (details see [11]). In fact, the “keeping warm” energy consumption exceeds the consumption for coffee and vapor production by far, even with short auto-power-down delays below 1 hour.

The aim of the measuring method is to identify the annual energy consumption. In the same way as for all devices and appliances with different modes and usages, the annual energy consumption has to be determined for uniform – i.e. standard – usage. The measuring method is based on a “standard use”, for which a typical number of “coffee periods” and the electricity consumption for coffee and vapor production (no measurement, standard value) are assumed. The typical “standard use” was investigated within the scope of the Swiss research project “Standby consumption of household appliances” [2].

The measuring method covers the operating modes ready (water is kept at temperature for an immediate cup of coffee), standby (water is not kept at temperature) and off. Coffee machines with flow-type heater entered the market newly; as they have no regular ready mode, the measuring method has been extended. For these machines coffee productions are a condition for activating from standby; therefore measured and normalized production energy consumption replaces the standard value otherwise used. Optional energy saving modes that are not activated in the factory setting can be included in an additional measurement. If a machine has accessory heating elements that can be switched off (e.g. heated cup trays, steamer), additional programmable modes can be measured next to the factory setting. The electricity consumption can be measured for coffee machines both with and without auto-power-down function.

The measuring method includes amongst others definitions, tolerances and control methods, instructions, measurement report, standard use and calculation of electricity consumption.

Criteria for Energy-efficient Coffee Machines of the Blue Angel and Topten

The Blue Angel and Euro-Topten have defined criteria for energy-efficient coffee machines. In order to be labeled by the Blue Angel and to be displayed on www.topten.info coffee machines must particularly meet the following technical criteria:

- Include an auto-power-down function switching off the permanent heating of the water after a certain time lag to standby or off.
- The time lag of the auto-power-down (auto-off) according to factory setting must not exceed 1 hour for fully automatic and piston hand-operated machines and 30 minutes for capsule machines.
- Power consumption in the standby (or sleep) mode following the auto-power-down must not exceed 1.0 W.
- The machine must have a mains switch (power consumption less than 0.3 W).
- Electricity consumption in the ready mode period defined by the Topten measuring method (E_{ready}) must not exceed 35 Wh for fully automatic and piston hand-operated machines, and 30 Wh for capsule machines. The Topten ready mode period is very simple: heating up from cold, re-activate after 30 minutes, reactivate again after 30 minutes, wait for auto-power-down.

Methods

- According to Euro-Topten “Measuring Method and Calculation Formula for the Electricity Consumption of Coffee Machines for household use” [8].
- Tolerances and control methods according to “Measuring Method and Calculation Formula for the Electricity Consumption of Coffee Machines for household use”.

Explanatory notes

- Typical coffee machines without auto-power-down use about three quarters of their total electricity consumption for the permanent keeping hot (ready) and in standby mode. Therefore assessment criteria must cover auto-power-down as well as the power consumption in ready and standby mode. Taking into account all three aspects guarantees that models with auto-power-down, but generating electricity losses in ready and standby mode higher than the savings, cannot be selected.
- The time lag to standby mode is a crucial factor and must not be based on generalized values. The time lag has to be included into the measurement the way it works in real usage situations. Otherwise, the measuring result of the major loss of electricity is incorrect. Especially if the time lag in reality is shorter than generally assumed, or with innovative approaches such as flow-type heaters the assumption of a typical value leads to incorrect results.
- As soon as there is a sufficient range of energy-efficient coffee machines on the market, the criteria regarding power consumption in the ready mode will be tightened (see recommendations below).
- The following aspects are not relevant for the electricity consumption and mainly depend on the consumers' individual preferences: pump pressure (preparing a “real” espresso requires at least around 8 bars), flavor of the coffee, noise and a machine's handling properties such as how it is switched on, how the coffee is received, how to clean or to decalcify it.

- It has been assumed that for coffee machines the electricity consumption during the use phase is environmentally more relevant than the production and the disposal phases, as it is the case in other electrical products with a high power consumption such as cooling appliances and freezers (e.g. EuP-studies cooling appliances [12]. A comprehensive analysis will be realised within the EuP study regarding coffee machines).
- Furthermore for the Blue Angel there are requirements concerning lifetime, material and consumer information [7].

Impact and Experiences with the Euro-Topten Measuring Method for Coffee Machines

The Euro-Topten measuring method for coffee machines is applied at:

- Best Products of Europe: Presentation of the most energy-efficient coffee machines on the European market (www.topten.info, 5 models, May 2009). Best Products of Europe is an aggregation of all national Topten-projects and displays the very best products all over Europe.
- Topten Switzerland: Presentation of the most energy-efficient coffee machines on the Swiss market (www.topten.ch, 24 Models, May 2009). The selection criteria on national Topten sites are still less stringent than on the European site www.topten.info.
- Austrian Energy Agency AEA: Presentation of the most energy-efficient coffee machines on the Austrian market (www.topprodukte.at, 16 Models, May 2009). The selection criteria on national Topten sites are still less stringent than on the European site www.topten.info.
- Most important Swiss retailers: Coop bases its label "Oecoplan" for high efficiency coffee machines on Euro-Topten selection criteria and measuring method. As from summer 2009 Migros is distinguishing Topten-Coffee machines at the point of sale as Topten-products.
- Over 30 energy consumption testings of coffee machines by order of retailers, environmental organizations and producers of coffee machines.
- German Energy Agency (dena): International competition and award of the most efficient coffee machines at the Domotechnica/Koelnmesse, February 2008 [13].
- European Commission: Award of the most efficient coffee machine at the Klagenfurt Fair in the framework of the "Euro-Topten Product Exhibition and Competition", September 2008.
- Promotion programs of Swiss electrical utilities to increase the market share of high efficiency coffee machines: Zurich Municipal Electric Utility (ewz, since autumn 2007 [14]), Berne Municipal Electric Utility (ewb, June 2009), Electric Utility Tamins (ewt, since 2008), Basel Municipal Electric Utility (iwb, during spring 2008).

Strategies to Enhance Energy Efficiency of Coffee Machines

Unlike many domestic appliances, a coffee machine's electricity consumption is not required to be declared up to date. Regarding the great differences between products and the high saving potentials by known simple technologies such as an auto-power-down function, better insulation of boilers and low standby consumption, an EU-energy label for coffee machines would be a very effective measure to raise efficiency of coffee machines. It would give incentives to trade and industry to develop and offer energy-efficient coffee machines. There are several initiatives aiming at defining criteria regarding the energy efficiency of coffee machines:

- In the framework of the IEE-project "Euro-Topten" and together with the Blue Angel a measuring method and calculation formula for the electricity consumption of coffee machines

have been developed. Furthermore, criteria regarding the energy efficiency of coffee machines have been defined. Both measuring method and energy efficiency criteria are being applied successfully (see above).

- At EU-level, energy efficiency of coffee machines is being studied, and policy measures will be dedicated. In the frame of the Ecodesign of Energy using Products (EuP) preparatory study Lot 25 [15] the introduction of standards, the obligation to declare electricity consumption, an energy label and minimum efficiency requirements will be taken into account.
- The German Federal Environment Ministry, the German Federal Environment Agency and the Environmental Label Jury have linked the Blue Angel to the global warming discussion and introduced an eco-label "Blue Angel for climate-relevant products". The project is conducted by Oeko-Institute covering ten product groups in a first phase (finished in april 2009), one of them being coffee machines [5], [6], and further 90 product groups in phase 2 (2009-2012).

Recommendations for Policy Design

The market of coffee machines in European countries is still extremely disperse. However, in all countries there are strong trends to higher sales figures and towards high end products (real espresso- and filter-pad machines instead of traditional filter systems). It is a great challenge to introduce energy efficiency measures in a country before a boom of first equipment acquisition.

The following aspects are recommended to be considered thoroughly in the EuP Lot 25 study:

- Minimum Energy Performance Standards (MEPS) based on the Blue Angel and Euro-Topten constraints:
 - Ready mode: 35 Wh (coffee fully automatic, piston hand-operated) respectively 30 Wh (capsule and pad machines) (tier 1). More stringent criteria should be foreseen for tier 2 (according to market development).
 - Standby: 1 Watt
 - Standby consumption is regulated already in tier 1 of the EuP Standby Directive (Lot 6 [16]), while auto-power-down is covered in tier 2 (the appliance must go into standby as quickly as possible).

However, it is very important that both functions – standby and auto-power-down – are also included in this horizontal measure for coffee machines. (Euro-Topten uses both terms auto-power-down and auto-off synonymously).

An auto-power-down automatically terminates the heating of a machine after a certain time of inactivity. This time lag should not exceed 1 hour.

- Efficiency potentials:
 - Better insulation of boilers
 - Optimizing of the auto-power-down
 - Low standby: see above
 - Standby and auto-power-down actually are covered by the EuP Standby Directive, Lot 6. Nevertheless it is crucial to include for coffee machines both modes in the horizontal measure.
 - Solution with continuous-flow heaters

- Profiting from the preliminary work done by Euro-Topten and the Blue Angel. Technical design standards for coffee machines on the basis of Euro-Topten measurement methodology and a standard usage pattern are suggested and might be incorporated into the IEC 60661 standard (Methods for measuring the performance of electric household coffee makers 2003-03) [17]).
- Introduction of an EU-Energy Label for coffee machines.
- Coffee machines could be included in the EcoLabel as well. The EU EcoLabel informs consumers that appliances meet certain ecological requirements during its entire life cycle (Legal base: regulation No. 1980/2000 (EC) on a revised Community Ecolabel award scheme, ec.europa.eu/environment/ecolabel/index_en.htm).
- Promotion programs are important to increase the market share of high efficiency coffee machines. Possibilities are rebate programs, information campaigns, or bonus-malus systems addressing producers.

References

- [1] GfK Group, Nuremberg, Germany, www.gfk.com
- [2] Nipkow, J., Bush, E.: *Stand-by consumption of household appliances*, Swiss Agency for Efficient Energy Use S.A.F.E. on behalf of the Swiss Federal Office of Energy SFOE, Berne 2003. Download from: www.electricity-research.ch (search: appliances)
- [3] Euro-Topten and Topten International Group TIG (Paris, France): www.topten.info
- [4] Topten-Selection of high efficiency coffee machines (Super Automatics, Capsule Espresso Machines, Selection criteria): www.topten.info
- [5] German Federal Environment Ministry (BMU), German Federal Environment Agency and Environmental Label Jury: *The Blue Angel – Active in Climate Protection. Labelling of particularly energy-efficient and climate-friendly products*. Joint press release from 19. 11. 2008, Berlin.
- [6] The Blue Angel: *Eco-Label and Climate Protection – Blue Angel for Climate-Relevant Products – Information Paper*. Press release from 19. 11. 2008.
- [7] RAL-UZ 136: *Espressomaschinen / Kaffeemaschinen mit hohem Druck. Vergabegrundlage für Umweltzeichen*. Ausgabe June 2009. *Previously unreleased*.
- [8] Euro-Topten and Swiss Agency for Efficient Energy Use S.A.F.E.: *Measuring Method and Calculation Formula for the Electricity Consumption of Coffee Machines for household use*. 2009. Download: www.topten.info
- [9] Swiss Agency for Efficient Energy Use S.A.F.E., Nipkow, J., Bush, E.: *Stand-by consumption of household appliances*, Presentation at EEDAL 2003 Conference, Torino.
- [10] Swiss Agency for Efficient Energy Use S.A.F.E., Nipkow, J., Bush, E.: *Energy label for Coffee Machines*, Presentation at EEDAL 2006 Conference, London.
- [11] Topten International Group TIG (Paris, France), Nipkow, J., Bush, E.: *Coffee machines: recommendations for policy design*. Download: www.topten.info
- [12] Preparatory studies for Eco-design Requirements of EuPs (Tender TREN/D1/40-2005). Lot 13: Domestic Refrigerators & Freezers.
- [13] German Energy Agency (dena), Award on the most efficient coffee machine: *Ausgezeichnete Kaffeefullautomaten. Strom sparen beim Kaffeetrinken*. Press release.

- [14] Ewz: Rebate and promotion program of Zurich for high efficiency coffee machines. More information: www.topten.ch
- [15] Bio Intelligence Service: *Non-tertiary coffee machines*. Preparatory studies for Eco-design Requirements of EuPs (TREN), Lot 25.
- [16] Ecodesign of EuP Products. Preparatory Studies Lot 6: Standby and OFF-mode Losses of EuPs.
- [17] IEC. *Methods for measuring the performance of electric household coffee makers*, international standard IEC 60661, Ed. 2.2, 2006-02.