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Non-Tertiary Coffee Machines

Task 6: Technical analysis of BAT and BNAT – Final version

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Bio Intelligence Service - Scaling sustainable development
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Bio Intelligence Service S.A.S - bio@biois.com
20-22 Villa Deshayes - 75014 Paris - France
Tél. +33 (0)1 53 90 11 80 - Fax. +33 (0)1 56 53 99 90

Contact BIO Intelligence Service
Shailendra Mudgal – Benoît Tinetti
☏ + 33 (0) 1 53 90 11 80
shailendra.mudgal@biois.com
benoit.tinetti@biois.com

Project Team

BIO Intelligence Service

Mr. Shailendra Mudgal

Mr. Benoît Tinetti

Mr. Lorcan Lyons

Ms. Perrine Lavelle

Arts et Métiers Paristech / ARTS

Mr. Alain Cornier

Ms. Charlotte Sannier

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6. TASK 6 – TECHNICAL ANALYSIS OF BAT AND BNAT

6.1. INTRODUCTION

The objective of this task report is to describe the main design options for improving the efficiency and environmental performance of non-tertiary coffee machines. It provides inputs for the identification of improvement potential in Task 7.

This task report entails description and technical analysis of Best Available Technologies (BATs) and Best Not yet Available Technologies (BNATs). BATs are currently available technologies that reduce environmental impacts and can be introduced at product level within 2-3 years. Technologies that lead to further reduction of environmental impacts but are still in development and expected to be introduced in 5-10 years time are BNATs. “Best” refers to the environmental performance of the product; “Available” refers to the technical and economic feasibility of implementing the technology and applies whether or not the technology is currently produced or used within the EU as long as it is reasonably accessible; “Not yet” available means subject to research and development but not yet on a scale that would allow implementation.

This report looks at improvement options for both individual components and whole products. Section 6.2 describes several BAT design options at component level. Five design options are selected for further analysis. In order to analyse possible trade-offs in terms of additional environmental impacts in the production, distribution or end-of-life phases, for each design option the differences in material composition between a standard product and a product with integrated design option(s) are presented. Furthermore, a rough estimate of the market share each BAT option already has is provided. State-of-the-art product technology outside the EU is also described. Section 6.3 takes a similar approach but at the level of the product as a whole.

Section 6.4 looks at BNATs: further design options that might improve the environmental performance of non-tertiary coffee machines but are currently under development (i.e. at prototype stage) and have not yet been implemented. Alternative technologies and BNATs from outside the EU are included.

Information for this task was gathered from a number of different sources. Major European manufacturers and NGOs provided inputs in response to a questionnaire[1]. The information on BATs was derived from manufacturer feedback supplemented by market research. Manufacturers were asked to provide estimates of costs and savings potentials. Feedback was received from three manufacturers.

[1] Four questionnaires filled by stakeholders (individuals or federations) were received.

Other research studies were also consulted to provide further insight into the current state of the art in non-tertiary coffee machine technology as well as the BNATs.

Stakeholders say they improve their products to comply with legislation, to obtain certification and labels (e.g. the Swiss energy label) and in response to consumer demand. They are divided as to the relative importance of these drivers, with some claiming to be driven mostly by legislation and others by consumer demand. In addition, some say they take a holistic perspective of reducing the overall carbon footprint of coffee along the supply chain.

It is important to note that information regarding the saving potential of improvement options should be seen in the following context:

- The standard measurement method for quantifying the energy consumption of non-tertiary coffee machines is currently being revised by CENELEC, and there are no standards requiring manufacturers to define the measurement procedure for potential savings (see Task 1).
- Energy savings depend on many different factors such as: ambient air temperature, water temperature, type of machine, user behaviour and, last but not least, the base or reference case to which savings are compared.
- Little or no systematic independent research is carried out on the potential saving impacts of improvement options.
- Manufacturers use a variety of terms to describe improvement options and assess their systems in a variety of ways.
- Figures in sales brochures are used for marketing purposes and might overestimate actual savings.
- Quantitative data provided by manufacturers with regard to savings potentials are estimations.

For the above reasons, estimations and quantitative data provided by different manufacturers diverge considerably. The data presented in this task report are average values.

6.2. DEFINITION OF BAT AT COMPONENT LEVEL

The emphasis in this section is on the improvement of individual coffee machine components, as a way to improve the product as a whole. The aim is to describe the best components that are already in use or will be used in future.

The importance of energy consumption in the use phase to overall life-cycle impacts has been shown in several studies and is thus a prerequisite for BAT. The energy consumption of non-tertiary coffee machines for coffee-making is mainly for water heating, with small amounts for motor energy for mechanical action, for electronics and heat losses. The amount of energy used for heating depends on the amount of water, the temperature of the cold water inlet and the temperature to be reached. The energy used for mechanical action depends on the type of coffee machine and its features. During the coffee-making process, the energy used to heat water also flows to other parts of the machine and is lost to the environment. That heat loss depends for example on the insulation, the ambient temperature (to a minor degree) and the temperature of the heated water.

The use phase for coffee machines extends beyond coffee-making. Use patterns tend to concentrate energy consumption in the ready-to-use and standby modes, and for drip filter machines in keeping coffee warm. Manufacturers thus focus on these modes in order to reduce energy consumption.

In terms of the machines themselves, the key development area cited by stakeholders is to increase the energy efficiency of components, followed by options to reduce end-of-life impacts. Improved insulation, optimisation of case design and other design options are less important and depend on the product concerned. Among components, some stakeholders cited electrical components, power supply modules and software as the components with the greatest potential for energy savings.

As mentioned above, consumers are said to demand improved products in general. However, they do not demand improvements to any specific product or component. In fact, the main requests are said to be for shorter heating-up times and higher in-cup temperatures.

6.2.1. DESCRIPTION OF BAT DESIGN OPTIONS

The options in this section have been selected based in large part on information from manufacturers and consumer organisations.[2] Each option is applicable to all non-tertiary coffee machines but may be more suited to a particular type of machine than to others.

6.2.1.1 OPTION 1: AUTO-POWER DOWN (AND SHORT DELAY TIME)

Reducing the duration of the ready-to-use mode is the first and very simple efficiency measure to consider. Stakeholders agree that auto-power down has the biggest potential to improve the energy efficiency of a coffee machine. Auto-power off would reduce energy consumption even more but would require a mechanical switch and the additional saving would not be justified if auto-power down is sufficiently low. The function is especially important for non-tertiary coffee machines that are used in office settings since they are seldom if ever switched off manually.

Auto-power down will be mandatory from 2013 onwards under the Standby Regulation.[3] However, the length of the delay before entering standby mode is not

[2] Nipkow, J. and B. Josephy (2010), "Best Available Technologies, general comments", private communication, 2 December 2010, topten.info.
[3] European Commission, No 1275/2008.

specified in the Regulation, nor is it specified if the delay is from the time the machine was switched on or from the time it was last used. According to stakeholders, the length of the delay before auto-power down is currently chosen in order to achieve a good classification in the available energy label (i.e. the Swiss energy label). In order for a non-tertiary coffee machine to be considered a BAT model, the auto-power down delay should be reasonable to also consider consumer's needs. Today, the lag is often around one hour and sometimes longer. Factory settings of new machines placed on the market have been shortened in recent years: for some models, the setting is still two hours or more, for many new models it is between 10 minutes and one hour and for a small number of models it is one minute or even less. Although a short delay might prove frustrating in offices, non-tertiary coffee machines are in any case intended for domestic use and their use in offices may contravene health and safety legislation. Another concern is that auto-power down might automatically initiate the rinsing process, using energy and water needlessly. However, this possibility should not be difficult to avoid.

6.2.1.2 OPTION 2: INSULATION OF HOT PARTS (THERMO-BLOCK, BOILERS, WATER HEATERS OF ANY KIND)

After auto-power down, insulation of the heater is the component that manufacturers focus on most. Thermal losses from heaters can be substantially lowered by even a thin amount of insulation on the hot parts. The insulation prevents the cooling effect of air ventilating those parts. Even with flow-through water heaters (see below) a further small efficiency gain from insulation can be expected. For drip filter coffee machines, this option corresponds to the use of an insulated jug. In such machines, a warming plate is normally not used.

6.2.1.3 OPTION 3: FLOW-THROUGH WATER HEATERS

The latest water-heating units, called flow-through water heaters or continuous-flow heaters, activate just before coffee production begins and they switch off once it is finished. Thus, auto-power down is much less relevant. With instant heating devices such as these, there is no ready-mode consumption. Today they can be found in many Bosch Tassimo machines.[4] Note that drip filter machines technically also use flow-through heating but with steam rather than pump pressure. Flow-through heaters are considered by some to be the most efficient water heaters for coffee machines, though others consider that thermoblocks can achieve similar results if combined with auto-power down (both technologies are types of heat exchanger). Some stakeholders also express concern that for espresso brewing, the in-cup quality may be affected by flow-through heaters due to the difficulty of controlling the final temperature of the coffee. Although flow-through heaters and thermoblocks can be considered equivalent in some respects, in the analysis Option 3 refers to a flow-through heater only.

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[4] See www.tassimo.co.uk/help/machines/900. Note that Tassimo machines are covered by Base-Case 2 because they are low-pressure portioned machines, even though they use hard caps rather than soft pads.

6.2.1.4 Option 4: "Zero standby"

"Zero standby", i.e. a standby mode with very low energy consumption, is now an established product feature in the appliances sector. TV sets, for example, use a standby mode because they are activated by remote control. However, as the use of a coffee machine requires the pressing of a button or another manipulation by the user anyway, there is in principle no need for a standby function and "zero" standby could be implemented. Note that "zero" in this case would not be absolute zero since there can still be a negligible amount of leakage as long as the machine is plugged in. Also, a very small amount of energy consumption would be required in machines with a display. Note, however, that for some models there could be some loss of functionality as very low standby could result in longer restart time or preclude an "auto-turn on" function.

6.2.1.1 Option 5: High-efficiency power supply

A high-efficiency power supply was mentioned by some stakeholders as a potential improvement option. However, the technical justification for significant energy savings as a result is not clear. It seems that the potential will be exploited anyway as a result of the Standby Regulation to cover power management systems. Standby includes more efficient power supply because it sets limits for energy consumption in off and standby modes. Therefore, the option has not been analysed further in this study.

6.2.1.2 Option 6: Reduced amount of water to be heated for hygienic and quality purposes

Most coffee machines heat some water for rinsing purposes when switched on or off, or they discard a small amount of coffee at the beginning of the brewing process because it might be not hot enough or of sufficient quality. The consumption of energy and resources (including chemicals) for decalcification and (automatic) cleaning should be considered and can be reduced in some cases, e.g. by reducing the temperature and volume of water used for these processes. However, for the assessment of the Base-Cases carried out in task 5, except the use of decalcifiers considered for calculating the LCC, considering that such functions have negligible environmental impacts compared to those caused by making coffee.

6.2.2. Potential of improvement options

Table 6-1 shows the impact that improvement options could have for various types of machine, according to stakeholders. Estimates of energy savings are provided in this table based on replies received from a questionnaire sent to stakeholders. The detailed assessment of energy savings and effects on other environmental impacts of these improvement options compared to the Base-Cases is carried out in Task 7. The actual values used are listed there.

Table 6-1: Impact of possible component level improvements (stakeholder inputs)

Improvement option	Applicability	Estimated energy reduction compared to BC	Increase in final price compared to BC
Auto-power down (e.g. 60, 30, 5 minutes)	All (though 5 minute delay could be considered short for BC 1, BC 4 and BC 5)	30-40% (BC 3)	<€1 (BC 3)
Zero standby	All		€3 (BC 3) €30 (BC 4, BC 5)
Additional insulation	All (thermos jug for BC 1), though potential savings small except for BC 1	5%; 30% (BC 3)	€5 (BC 3), €10 (BC 5)
Improved insulation material	No; not expected in 2-3 years		€30-100
Flow-through heater	BC 2-5	35% (BC 2), 10% (BC 3-5)	€50 (BC 3); €20-50 (BC 2-5)

The improvement options 1 to 4 described in section 6.2.1 lead to a reduction in energy demand during the use phase. In order to analyse possible trade-offs with environmental impacts in the production, distribution or end-of-life phases, differences in material composition between a basic product and a product with integrated design options were investigated.

Additional material consumption for these options is not significant. For example, most modern coffee machines are already equipped with electronics to control water and brewing temperatures etc. Manufacturers did not state any change in material composition. The additional input is mainly technical knowledge and some electronics.

6.3. DEFINITION OF BAT AT PRODUCT LEVEL

6.3.1. BEST-PERFORMING PRODUCTS ACCORDING TO STAKEHOLDERS AND PAST AND FUTURE IMPROVEMENTS

This section considers the product as a whole. Comparisons of past, present and expected future products can give an idea of the evolution of non-tertiary coffee machines and medium-term trends, though some stakeholders claim the market is developing too rapidly to provide estimates even in the short run. One trend that is clear is that manufacturers have been modifying their products to comply with the Standby Regulation.

In Table 6-2, each row corresponds to a product as reported by a stakeholder. In Tables 6-3 and 6-4, the ranges of values reported for each Base-Case are shown.

Table 6-2: Best-performing products as reported by stakeholders

Type	Year of market entry	Final price including VAT (euros)	Power consumption in standby[5]	Power consumption in ready-to-use mode	Default auto-power down delay (minutes)	Energy-saving (reduced water temperature) mode delay (minutes)[6]
BC 1[7]	2007	55	0 W	n.a.	Immediate	n.a.
BC 1	2009	50	0 W	n.a	120	n.a.
BC 2	2010	89	0.4 W[8]	15 W	30	n.a.
BC 2[9]				0 W	Immediate	
BC 3	2009	189	<0.5 W	10 W	30	n.a.
BC 3	2008	549	<1 W	10 W	30 - 720	n.a.
BC 5	2010	600 - 1 000	1 - 2 W[10]	<10 W	5 - 60	5 - 60
BC 5	2010	1 099	0.5 W	n.a	30 - 96	5 - 60

[5] Ranges depend in part on whether or not a display is available.
[6] This column is for information only; the feature is not considered BAT.
[7] Drip filter coffee machine with thermo-jug and automatic switch-off after brewing.
[8] Measurement method: Swiss energy label (FEA/CECED).
[9] Low-pressure portioned (e.g. Tassimo)
[10] Measurement method: IEC 62301.

Table 6-3: Average products in Europe as reported by stakeholders

Type	Year	Final price including VAT (euros)	Power consumption in standby	Power consumption in ready-to-use mode	Default auto-power down delay (minutes)
BC 1	2010	35 - 50	0 - 2 W[11]	n.a.	120
	2007	35 - 50	0 - 3 W	n.a.	120 - 150
BC 2	2010	81	0 - 2 W[11]	15 - 30 W[12]	30 - 60
	2007	81	0 - 3 W	15 - 30 W[12]	30 - 60
BC 3	2010	129 - 156	<0.5 - 2 W	10 W[12]	9 - 60
	2007	156 - 249	2 - >4 W	10 - 18 W[12]	<180
BC 4	2010	103	n.a.	18 W[12]	n.a.
	2007	120	n.a.	18 W[12]	n.a.
BC 5	2010	595	1 - 2 W[11]	<20 W[12]	60
	2007	500	3 - >4 W	50 W[12]	120

[11] Measurement method: IEC 62301.
[12] Measurement method: Swiss energy label (FEA/CECED).

Table 6-4: Short-term improvement (2012-2013) as reported by stakeholders

Type	Final price including VAT (euros)	Power consumption in standby	Power consumption in ready mode	Default auto-power down delay
BC 1	40 - 45	0.5 - 1	n.a.	5 - 120[13]
BC 2	90	0.5 - 1	15 - 30 W[14]	30 - 60
BC 3	165	<0.1 - 2 W[15]	5 - 10 W	6
BC 4		1 - 2 W[15]	20 W	n.a.
BC 5		1 - 2 W[15]	<5 W	60

[13] Between 5 and 60 minutes depending on the setting, and two hours until the heating plate is automatically switched off.
[14] Measurement method: Swiss energy label (FEA/CECED).
[15] Measurement method: IEC 62301.

6.3.2. Best-performing products according to Topten

The Topten website (www.topten.info) presents an overview of the best-performing fully automatic and capsule machine (pad filter and hard cap) products in Europe.[16] Filter coffee machines and commercial appliances with a permanent water supply are not considered. The selection is made only from those suppliers that provide data.

The coffee machines displayed on the website meet the following criteria:

A) Fully automatic machines

- Time lag of the auto-power down, factory setting: maximum 1 hour
- Power consumption in standby (or sleep) mode following the auto-power down: maximum 1 W
- Electricity consumption in ready mode: maximum 35 Wh

B) Capsule machines (hard cap and pad filter)[17]

- Time lag of the auto-power down, factory setting: maximum 30 minutes
- Power consumption in standby (or sleep) following the auto-power down: maximum 1 W
- Electricity consumption for ready mode: maximum 30 Wh

Some of these models have a very short auto-power down delay time and zero standby consumption.

Products are ranked according to their electricity costs over a period of 10 years.[18] Electricity consumption is measured according to the "Euro-Topten Measuring Method and Calculation Formula for the Electricity Consumption of Coffee Machines for Household Use".[19] The two top-ranked products from each category are presented in the tables below.

[16] See www.topten.info/english/household/coffee_machines/super_automatics.html and www.topten.info/english/household/coffee_machines/capsule_espresso_machiines.html.
[17] Topten says it does not have information on other types of portioned machines such as pad machines meet the criteria so they are not yet included.
[18] The electricity tariff used is €0.15/kWh. It is recognised that there can be large differences depending on the country and the electricity utility.
[19] See www.topten.info/english/criteria/coffee_machine_ak.html&fromid=.

Table 6-5: Best available fully automatic coffee machines according to www.topten.info

Brand	Nivona	Rotel	Rotel	Krups	Inefficient
Model	CafeRomantica 750	AroMatica 755	Adagio 330	EA 8010	No auto-power down
Similar models	NICR605 / 650 / 730 / 735 / 770	Aromatica 751 / Aromatica 753	Adagio 310	Rowenta / ES6910	-
Pump pressure (bars)	15	15	15	15	15
Electricity cost over 10 years (€)	60	62	63	63	294
Energy per year (kWh)	40	41	42	42	196
Standby mode (W)	0	0	0	0.5	3.6
Switch-off delay (minutes)	60	30	30	60	n.a.
Countries	AT, CZ, NL	CH	CH	AT BE CH DE ES FI FR NL PT	-

Table 6-6: Best available pad filter and hard caps coffee machines according to www.topten.info

Brand	Bosch	Bosch	Bosch	Delizio	Krups	Cremesso	Delizio	Inefficient
Model	Tassimo 4011CH	Tassimo T20	Tassimo 6515 CH	Comfort II	Nescafé Dolce Gusto Fontana KP3002	Compact	Compact	No auto-power down
Pump pressure (bars)	3.3	3.3	3.3	22	15	22	22	15
Electricity	45	48	48	51	53	53	53	294

cost over 10 years (€)								
Energy per year (kWh)	30	32	32	34	35	35	35	196
Standby mode (W)	0.7	0.7	0.9	0.05	0.4	0.25	0.25	3.6
Switch-off delay (minutes)	0	3	0	1	5	1	1	n.a.
Countries	AT CH DE ES FR	AT CH DE ES FR	AT CH DE ES FR	CH	CH ES	AT	CH	-

6.3.3. Best-performing products according to the Swiss FEA/CECED energy label

In Switzerland, an energy label is already in place as presented in Task 1. It uses an energy consumption measurement method developed by the Swiss FEA with the European association CECED.

Table 6-8: Selected A-grade coffee machines bearing the Swiss FEA energy label[20]

	Fully automatic		Hard cap	
Brand	DeLonghi	Saeco	Nespresso König	Nespresso König
Model	ECAM 23.210.B Intensa	Saeco XSmall Plus H13220	CitiZ	Capri Automatic
Pump pressure (bars)	15	15	19	19
Indicative retail price (€)	799	599	269	199
Electricity costs over ten years (€)	71	87	55	63
Energy per year (kWh)[21]	47	58	37	42

[20] Source: www.melectronics.ch, accessed December 2010.
[21] Calculated using the same electricity tariff used by the TopTen website, i.e. €0.15/kWh.

Standby mode (W)	-	-	0.9	0.8
Default switch-off delay (minutes)	120 (range programmable between 15 and 180)	60	30	30

6.3.4. BAT OUTSIDE THE EU

Although the Ecodesign Directive applies to the EU common market, state-of-the-art technologies may also found outside the EU. However, it was stated by manufacturers that the most advanced coffee machine technologies and the most efficient non-tertiary coffee machines are produced in the EU. Even the United States coffee machine industry seems to be far behind Europe as its coffee machines use more energy than European products. Thus no further improvement options for non-tertiary coffee machines from outside the EU were identified.

6.4. DEFINITION OF BNAT

This section focuses on product research in the EU as applied to components such as case design, new materials, heating elements or user modes. In order to gain an overview of future developments and long-term saving potential in the non-tertiary coffee machines sector, manufacturers were asked to name improvement technologies that are expected to be introduced within five to ten years. They were also asked to estimate energy saving potential.

Although manufacturers emphasised that the sector is still subject to research and development efforts, it should be noted that for competition reasons, manufacturers are very reluctant to talk about inventions, ideas and strategies that are not yet available on the market. Competition between the manufacturers is fierce and the circle of leading manufacturers is rather small. For this reason the information received from manufacturers may be incomplete.

The following information was gathered through a questionnaire:

- Drip filter coffee machine: long-term improvement option will focus on improving the thermal insulation of the jug; the heating unit can also be better insulated, thereby reducing heat loss during brewing;
- Hard cap espresso machine: improving the energy efficiency of the appliance will still be the main focus of R&D. It can be expected that the standby power consumption in 5-10 years will be below 0.1 W and that the electricity consumption in ready-to-use (RTU) mode will be below 1 Wh/h. The use of the

auto-power down function would not be necessary anymore due to the low consumption in RTU mode (or due to the use of a flow-through heater).

- Fully automatic espresso machine: some manufacturers claim that the main focus is on continuous improvement in espresso brewing quality to satisfy customers' requests. Energy efficiency may not be the first focus for manufacturers for this type of coffee machine.

Other technical breakthroughs expected by manufacturers are: electronics boards that consume less energy; shorter (EU) supply chains; more efficient thermal insulation; greater freedom of intellectual property concerning energy consumption; new machines designed to be compatible with alternative energy sources.

One improvement option mentioned by manufacturers that has not yet been applied to hard cap espresso coffee machines is the flow-through water heater. As described above, this is an instant heating device that will switch on only when hot water is required. This will avoid energy consumption in ready mode. This feature is already available in soft pad espresso machines and in France in the "Special T" hard cap tea machine[22] but not yet in BC 3 machines.

6.4.1. BNAT OUTSIDE THE EU

Although the Ecodesign Directive applies to the EU common market, for many products state-of-the-art technologies may also be found outside the EU. However, manufacturers state that the most advanced coffee machine technologies and the most efficient non-tertiary coffee machines are produced in the EU. Even the United States coffee machine industry seems to be far behind Europe as its coffee machines use more energy than European products. Thus no further improvement options for non-tertiary coffee machines from outside the EU were identified. EU manufacturers say they use the same standards and technologies even where requirements are less strict.

6.4.2. ALTERNATIVE TECHNOLOGIES

Humbert *et al.* (2009) made a comparative LCA of "spray dried soluble" (instant) coffee, drip filter coffee and hard cap coffee.[23] The authors found that around half of the total life cycle environmental impact of instant coffee occurs pre-consumer (cultivation, treatment, processing, packaging, distribution and advertising) and half during the use phase and disposal. It was found that instant coffee has a lower environmental footprint than capsule coffee, which in turn has a lower environmental

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[22] See www.nestle.com/MediaCenter/PressReleases/AllPressReleases/Nestle-launches-pioneering-tea-machine-system-Special-T.htm.

[23] Humbert, S., Loerincik, Y., Rossi, V., Margni, M. and O. Jolliet (2009) "Life cycle assessment of spray dried soluble coffee and comparison with alternatives (drip filter and capsule espresso)" in *Journal of Cleaner Production*, 17 (2009) 1351–1358, Elsevier.

footprint than drip filter on a per cup basis. It has to be noted that the assumption was made that one third of the drip filter coffee is wasted and the machine had a standby delay of two hours.

However, despite the life cycle benefits of instant coffee, it is not clear whether instant coffee can be presented as a realistic alternative in the context of this study. Most consumers would say that the quality (i.e. the functionality) of instant coffee is inferior to that prepared by an espresso machine or even a drip filter machine. Indeed, the differences between beverages with “espresso” and “coffee” tastes are such that they may almost be considered alternative technologies.

Other alternatives exist but with significantly different functionalities. For example, a new patented technology has appeared recently on the market, the Handpresso[24]. This technology allows preparation of an espresso (pressure up to 16 bars) with a manual pump, using either pads or ground coffee. However, hot water has to be added and therefore such an appliance is not technically an energy-using product.

[24] See www.handpresso.com.

6.5. CONCLUSIONS

The analysis of BAT in this report identified several options for improving the environmental performance and energy efficiency of non-tertiary coffee machines. These Bats aims at either:

- Reduce the time in ready-to-use mode, or
- Reduce the electricity consumption in ready-to-use mode, or
- Reduce the electricity consumption in standby mode.

Sales of these machines are increasingly rapidly so what might be considered BNAT can become BAT very quickly. Improvements tend to be integrated within the typical design cycle of these products. BNAT options therefore tend to relate to changes in product type. The application of these improvement options into the Base-Cases will be assessed in Task 7 on both environmental and economic aspects.

Some alternative technologies exist to produce a cup of coffee such as the use of instant coffee with water warmed in a kettle. However, such a process cannot produce an espresso and thus the quality of the coffee is not comparable.