

EuP – Lot 24: Professional washing machines, dryers and dishwashers

Task 6: Technical Analysis of Best Available Technologies

Final Stakeholder Meeting on Washing machines and dryers
Brussels, 12 January 2011

(Öko-Institut e.V. / Bio Intelligence Service)



Task 6 – Technical Analysis BAT

- **State-of-the-art in applied research for the product (prototype level)**
- **State-of-the-art at component level (prototype, test and field trial level)**
- **State-of-the-art of best existing product technology outside the EU**

Structure presentation:

- **Washing machines → Discussion**
- **Dryers → Discussion**

- **Analysis of energy consumption and losses**
- **Description of principal design options to improve energy and water consumption**
- **Estimation of reduction potential (energy and water consumption) of different improvement options and their impact onto material composition**
- **Selection of the most important BATs**
- **Analysis of possible BAT combinations**
- **Description of the current best available products**

Data collected from

- sales brochures, supplemented
- By personal communication with input from 3 manufactures
- a working paper with input from one stakeholder feedback
- **a complementary questionnaire for Task 6 and 7 to consolidate the current results and the influence of implemented options on the consumption and the prices detailed by base-case ([see further presentation](#))**

- water heating, the motor energy for the mechanical action, for other electronics devices and heat losses are the most important fractions
- **90% of the energy losses can be allocated to the water heating**
- **Water heating:** influenced by the amount of water, the wash load, the temperature of the cold water inlet and the temperature to be reached
- **Mechanical action:** depends on the total washing time
- **Heat loss:** depends on the insulation, the ambient temperature and the temperature of the heated water
- **Focus on reducing water consumption**

Categories of Improvement Options:

- **T 1: Technological options considered best available technology (BAT), (reductions in energy and water)**
- **I 1: Infrastructure options considered best available technology (BAT),**
- **R 1: Research options considered best not available technology (BNAT),**
- **Improvement options outside EU**

Design options:

- **T 1.1: Increases motor efficiency (compared to a three phase AC)**
- **T 1.2: Electronic stop control**
- **T 1.3: Integrated automatic weighting system / automatic load control**
- **T 1.4: Water and temperature sensors**
- **T 1.5: Wash process with lower temperature / trend to cold water**
- **T 1.6: Alternative water (rinsing) phase optimisation**
- **T 1.7: Drum construction**

Design options:

- **T 1.8: Automatic detergent dispensing**
- **T 1.9: High extraction**
- **T 1.10: User friendly (voice) / intelligent control systems**
- **T 1.11: Heat exchanger**
- **T 1.12: Water recovery and waste water heat recovery**
- **T 1.13: Polymer pellets (beads)**
- **T 1.14: Ozone**

T1: Technological options – BOM example

Design Option	T 1.7	T 1.8	T 1.9	T 1.10	T 1.11	T 1.12	T 1.13	T 1.14
Material category	Drum construction	Automatic detergent dispensing	High extraction	User friendly (voice) / intelligent control systems	Heat exchanger	Water recovery and waste water heat recovery	Polymer Pellets	Ozone
	[g]	[g]	[g]	[g]	[g]	[g]	[g]	[g]
Bulk plastics								
PP								
Ferrous metals								
stainless steel								
Galv. Steel								
Non-ferrous metals								
copper wire								
Al diecast								
Electronics								
Misc.								
refrigerant					2 000 – 5 000			

Note: empty fields = not applicable or no response by manufacturers

→ Stakeholders are strongly asked to provide further information

Design options:

- **I 1.1: Hot water operated heating**
- **I 1.2: Gas-operated heating**
- **I 1.3: Steam-operated heating (or thermo –oil)**

Environmental improvement potential at infrastructure level:

- Existing supply system can be adapted to the state of the art or using BAT. (e.g. an existing steam supply could be substituted by a new, energy efficient steam supply in laundries).
- Conversion of the energy supply structure of laundries. (e.g. an existing central steam supply can be converted to a system with decentralised gas heating)
- improvement potentials by “media integration” → energy flow between different process steps within a laundry is optimised. (e.g. energy from the ironer’s exhaust for (pre-)heating wash water or the filtration and recycling of batch washer’s waste water for washer extractors)

→ However, such concepts at the infrastructure level can not be considered in this study more detailed or at a quantitative level

Stakeholders did not mentioned any other improvements options apart from BAT

Possible BNAT options (own assumptions):

- **R 1.1: Smart portal display (changes to appliances operation)**
- **R 1.2: Intelligent laundry contamination / stain sensors**

Improvement options outside EU

- It was stated by all manufacturers that the most advanced washing machine technologies are produced in the EU
- No further improvement options for professional washing machines are known

Note: same issue for the dryers

Nearly all improvement options can be implemented in each category except...

- **A heat recovery system is not applicable in the case of wash processes with lower temperature**
- **Likewise all improvement options helping to reduce water are not suitable to water recovery systems.**
- **In general one heating supply is used**

Design options / components for professional washing machines

Design options / component for professional washing machines		Application to the market in % ^[1]	Saving potential in %			Additional costs for users in EUR
			Energy	Water	Process time	
T 1.1	Increased motor efficiency	~90	~5	0	5	50-80
T 1.2	Electronic Stop controls	70-100	0-0,5	0	0	~3 -5
T 1.3	Integrated automatic weighing system / automatic load control	30-80	20-50	30-40	10	20-500
T 1.4	Water and temperature sensors	80-100	~10	~10	~10	50-80
T 1.5	Wash process with lower temperature / trend to cold water	35-50	50-70	0	- 30	n.a.
T 1.6	Alternative water (rinsing) phase optimisation	40-70	5	5	5	n.a.

[1] Depends on the different customer segment and washing machine category

→ Stakeholders are strongly asked to provide further information.

Design options / components for professional washing machines

T 1.7	Drum construction	20 - 40	0-20	0-10	0	100-500
T 1.8	Automatic detergent dispensing	10-30	0	0	0	400-600
T 1.9	High extraction ^[1]	60-80	+5	0	+5	100-4 000
T 1.10	User friendly control systems	30-50	0 - 5	0 - 5	~5	n.a.
T 1.11	Heat exchanger	5-60	20 - 50	0	5	5 000 – 8 000
T 1.12	Water recovery	5-80	20 - 50	20 - 60	0	1 000 – 4 000
T 1.13	Polymer Pellets	0	n.a.	n.a.	n.a.	n.a.
T 1.14	Ozone	0	n.a.	n.a.	n.a.	~1 000
I 1.1	Hot water operated heating	20	20 - 40	n.a.	20	n.a.
I 1.2	Gas-operated heating	1-10	n.a.	n.a.	20	n.a.
I 1.3	Steam-operated heating	10-100	n.a.	n.a.	15	n.a.
R 1.1	Intelligent laundry contamination sensors	0	40-50	30-40	20-30	n.a.
R 1.2	Smart portal display	0	10-30 ^[2]	n.a.	n.a.	5-55

^[1] The more water is removed by spinning in the washing machine the less thermal energy is required for subsequently drying process

^[1] Depends on the different customer segment and washing machine category

→ Stakeholders are strongly asked to provide further information.

Technologies built into the best available products on the market



Washing machine categories, base cases	Contained improvement options
WM1 Semi-professional washer extractor	Electric heating, electronic stop controls, high extraction, drum construction, water and temperature sensors,
WM2 Professional washer extractor, <15 kg	Electric heating, electronic stop controls, drum construction, water and temperature sensors,
WM3 Professional washer extractor, 15-40 kg	Electric heating , electronic stop controls, Drum construction, automatic weighing system, water and temperature sensors,
WM4 Professional washer extractor, >40 kg	electronic Stop controls, drum construction, automatic weighing system, Intelligent water and temperature sensors, High extraction, Control system (with an industrial programmable logistic controller for the hole laundry process)
WM5 Professional washer dryer	Electric heating, electronic stop controls, drum construction, automatic weighing system
WM6 Professional barrier washer	Electric heating , electronic stop controls, drum construction, automatic weighing system
WM7 Washing tunnel machine	Control system (with an industrial programmable logistic controller for the hole laundry process),

→ Stakeholders are strongly asked to provide further information.

Energy and Water consumption of the best available products

	WM1		WM 2		WM 3		WM 4	
	Consumption of energy in kWh / per kg laundry and water in litres per kg laundry							
	Energy	Water	Energy	Water	Energy	Water	Energy	Water
Standard product (see task 3)	0,14	9	0,17	12	0,17	12	0,18	12
Best available product on the market	0,12	8	0,15	10	0,14	9	0,10	10
Energy saving in percentage	~14%	~11%	~12%	~17%	~18%	~25%	~44%	~17%

→ Stakeholders are strongly asked to provide further information.

Energy and Water consumption of the best available products

	WM 5		WM 6		WM 7	
	Consumption of energy in kWh / per kg laundry and water in litres per kg laundry					
	Energy	Water	Energy	Water	Energy	Water
Standard product (see task 3)	0,80	10	0,25	14	0,35	6
Best available product on the market	0,78	9	0,22	12	0,30	5
Energy saving in percentage	~3%	~10%	~12%	~14%	~14%	~16%

→ Stakeholders are strongly asked to provide further information.

Options not be studied in the next step and in Task 7:

- “Increased motor efficiency” (T 1.1), “Energy stop controls” (T 1.2), “Intelligent water and temperature sensors” (T 1.4), “Increase of spinning speed” (T 1.9):
→ options are already implemented in standard machines.
- “Automatic detergent dispensing” (T 1.8), Polymer Pellets (T 1.14) and “Ozone” (T 1.15): no data available on energy and water savings
- Infrastructure level can not be outlined more profoundly in this study → highly depended on the site specific boundaries and side conditions
- Smart portal display: for professional appliances no data available on energy savings and costs

Different application possibilities for each washing machine category

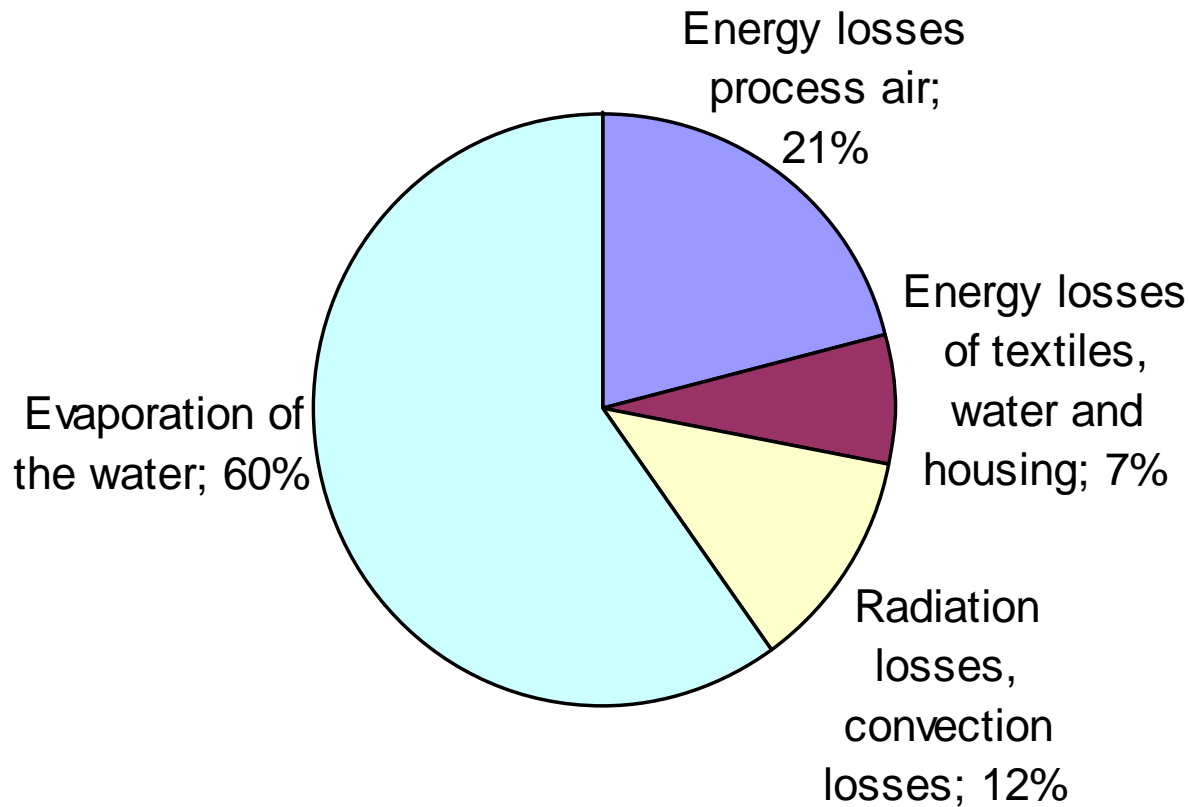
Design options	Base case						
	1	2	3	4	5	6	7
	Semi-profess. washer extractor	Profess. washer extractor <15 kg	Profess. washer extractor 15-40 kg	Profess. washer extractor >40 kg	Profess. wash dryer	Profess. barrier washer	Washing tunnel machines
T 1.1 Increased motor efficiency	X	X	X	(X)	X	(X)	(X) ^[1]
T 1.2 Electronic stop controls	X	X	X	X	X	X	
T 1.3 Integrated automatic weighing system / automatic load control	X	X	X	X	X	X	(X)
T 1.4 Water and temperature sensors	X	X	X	X	X	X	X
T 1.5 Wash process with lower temperature / trend to cold water	X	X					
T 1.6 Alternative water (rinsing) phase optimisation	X	X	X	X	X	X	X
T 1.7 Drum construction	X	X	X	X	X	X	
T 1.8 Automatic detergent dispensing	(X)	X	X	X	X	X	(X)
T 1.9 High extraction	X	X	X	X		X	
T 1.10 User friendly control systems	X	X			(X)		
T 1.11 Heat exchanger			(X)	X		(X)	X
T 1.12 Water recovery			(X)	X		(X)	X
T 1.13 Polymer Pellets	X	X	X	X	(X)	(X)	n.a.
T 1.14 Ozone	X	X	X	X	(X)	X	n.a.
Number of options relevant for task 7	5	5	3	5	3	3	3

[1] Advanced tunnel washer (improved tunnel washer design)

- Heat losses differ from type to type
 - Influence of ambient conditions,
 - Exhaust air, evaporation of the water and the radiation losses are the most important fractions for heat losses
- the heating of the air represents roughly 90% of the energy usage, 10% Motor
- The energy consumption is influenced by some aspects of washing machines
 - classification between categories of losses is not consistent
 - Fraction of losses depending on total energy input
 - The measurements are not done according to a standard measurement system

Improvement Potential dryers – Main areas

Energy use for a typical professional condenser dryer



Source: Universität Bonn, Haushaltstechnik and: Electrolux/AEG

Design options

- **T 2.1** **Increased motor concept**
- **T 2.2** **Heat pump**
- **T 2.3** **Heat recovery from exhaust air**
- **T 2.4** **Improved condensing units**
- **T 2.5** **Improved air flow system (axial, radial, mixed, other)**
- **T 2.6** **Air control system (improved drying temperature and cooling range)**
- **T 2.7** **Drum reverse action**
- **T 2.8** **Integrated automatic weighing system / automatic load control**
- **T 2.9** **User friendly (voice) control systems**
- **T 2.10** **Control systems**
- **T 2.11** **Improved insulation**

T2: Technological options - BOM

Design Option	T 2.1	T 2.2	T 2.3	T 2.4	T 2.5	T 2.6
Material category	Increased motor efficiency	Heat pump	Heat recovery from exhaust air	Heat recovery trough condensing unit	Improved air flow system	Air control system
	[g]	[g]	[g]	[g]	[g]	[g]
Bulk plastics						
PP						
Ferrous metals						
stainless steel						
Non-ferrous metals						
copper wire						
Al diecast						
Electronics						
Misc.						

Note: empty fields = not applicable or no response by manufacturers

→ Stakeholders are strongly asked to provide further information.

Infrastructure options:

- **I 2.1: Gas- operated heating**
- **I 2.2: Steam-operated heating**

Possible Research options :

- **R 2.1: Microwave dryer**
- **R 2.2: Vacuum dryer**
- **R 2.3: Smart portal display (changes to appliances operation)**

Nearly all improvement options can be implemented in each category except

- **Due to the free programmable control systems and the well trained operators it makes no sense to implement the user friendly voice system to other categories except D1-2**
- **The improved condensing unit is restricted to machines with additional heat pump and also to steam or gas operated machines.**
- **The implementation of some improvement options requires space. It would be difficult to integrate a heat pump into semi-professional machines.**
- **The air-flow design option and cannot be implemented in the condenser dryer (category D 1).**

Design options / components for professional dryers

Design options / component for professional dryers		Application to the market in %	Energy savings in %	Time savings in %	Additional costs for consumers in euro
T 2.1	Increased motor concept	30	~ 5	0	10 - 100
T 2.2	Heat pump	3 - 5	40 - 60	-50	n.a.
T 2.3	Heat recovery from exhaust air	10	10 - 45	0	700 – 3 000
T 2.4	Improved condensing units	10 - 30	5 - 15	0 - 5	50 - 60
T 2.5	Improved air flow system	40 - 60	5 - 30	5 -10	50 - 100
T 2.6	Air control system	~5	10 - 15	0	10 - 50
T 2.7	Drum reverse action	90	5 - 10	10	60 - 100
T 2.8	Integrated automatic weighing system	0 - 5	0 -10	0 -10	10 - 250
T 2.9	User friendly (voice) control systems	60	5	5	n.a.
T 2.10	Control systems	30 - 90	20	~0	5 - 20
T 2.11	Improved insulation	20	5	5	50 - 120
I 2.1	Gas-operated heating	30 - 70			30 - 50
I 2.2	Steam-operated heating	5	-80	30	100
R 2.3	Smart portal display	0	5-15 ^[1]	10-100	10-100

[1] University of Bonn, Synergy Potential of Smart Domestic Appliances in Renewable Energy Systems, Prof.Dr. R. Stamminger (Stamminger 2009)

Stakeholders are strongly asked to provide further information.

Technologies built into the best available products on the market



Dryer categories, base cases	Contained Improvement options
D1 Semi-professional dryer, condenser	Electric heating, control system,
D2 Semi-professional dryer, air vented	Electric heating, control system, Improved air flow system
D3 Professional cabinet dryer	Electric heating, heat pump, control system (adjustable)
D4 Professional tumble dryer, <15 kg	Gas heating, Heat pump, exhaust duct not needed, control systems (RMC), improved air flow system
D5 Professional tumble dryer, 15-40 kg	Gas heating, controls systems (RMC), Improved air flow system
D6 Professional tumble dryer, > 40 kg	Gas heating, control systems, (with an industrial programmable logistic controller for the hole laundry process)
D7 Pass-through (transfer) tumble dryer	Steam heating, infrared control, control system (with an industrial programmable logistic controller for the hole laundry process), heat recovery system

→ Stakeholders are strongly asked to provide further information.

Energy consumption of the best available products

	D 1	D 2	D 3	D 4	No 5	No 6	No 7
	Consumption of energy in kWh per kg laundry						
	Energy	Energy	Energy	Energy	Energy	Energy	Energy
Standard product (see task 3)	0,60	0,56	0,70	0,55	0,65	0,85	0,6
Best available product on the market	0,40	0,42	0,22	0,22	0,44	0,66	0,45
Energy saving in percentage	- 33%	- 25%	- 68%	-60%	- 32%	- 22%	- 25%

→ Stakeholders are strongly asked to provide further information.

Dryers options not be studied in the next step and in Task 7:

- Smart portal display: for professional appliances no data available on energy savings and costs)
- Steam operated dryers: no data available on energy savings,
- The drum reverse action, the defined base cases already include the drum reverse action, because this option is allocated with more than 90 percent on to the market.

Different application possibilities for each dryer category

Design options	Base case						
	1	2	3	4	5	6	7
	Semi-professional dryer, condenser	Semi-professional dryer, air vented	Professional Cabinet dryer	Professional tumble dryer, <15 kg	Professional tumble dryer, 15-40 kg	Professional tumble dryer, > 40 kg	Heavy duty pass-through (transfer) tumble dryer
T 2.1 Increased motor concept	X	X	X	X	X	X	X
T 2.2 Heat pump	X	X	X	X	X	X	(X)
T 2.3 Heat recovery from exhaust air		X	X	X	X	X	X
T 2.4 Improved condensing units	X	(X)	(X)	(X)	(X)	(X)	
T 2.5 Improved air flow system		X	X	X	X	X	X
T 2.6 Air control system (improved drying temperature and cooling range)		X	X	X	X	X	X
T 2.7 Drum reverse action	X	X	X	X	X	X	X
T 2.8 Integrated automatic weighting system / automatic load control	X	X		X	X	X	
T 2.9 User friendly (voice) control systems	X	X					
T 2.10 Control systems	X	X	X	X	X	X	X
I 2.1 Gas-operated heating				X	X	X	X
I 2.2 Steam-operated heating					X	X	X
R 2.1 Smart portal display (changes to appliances operation)	X	X	X	X	X	X	X
Number of options relevant for task 7	6	8	5	8	8	8	6

→ Stakeholders are strongly asked to provide further information.

- **no standard measurement method to quantify the consumption**
- **The savings depend on many different factors (uncertainty)**
- **Most of the data are approximation**
- **Figures from sales brochures are used for marketing propose**
- **Manufacturers use varied terms for their improvement options and assess their innovative systems to their competitors in different ways.**
- **There is no or little independent research on this subject**
- **The results of improvement options can not be easily measured.**

- **There is a high potential for energy (especially for dryers) and water savings regarding the least efficient products in the market**
- **To analyse and to lift the treasure, the machines have to be measured with a standard measurement method (incl. cleaning & hygienic test)**
- **The analysis has to be done by an independent institute.**
- **The information should be published within the sales brochure, in internet and at the products.**
- **Quantifications of energy savings of BAT should be based on reliable consumption and market data**

Thanks for your attention!

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