Topten Product Criteria Paper on

Tumble driers

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The Project in brief

Topten is part of the international Euro-Topten Plus initiative supported by the European programme Intelligent Energy Europe and several national institutions (energy agencies, WWF, consumer associations, research institutes). On global level, Topten is co-ordinated by TIG, the Topten International Group. This association promotes to the Topten Charter, TIG statutes and Rules of Procedure (www.topten.eu).

Topten is a service that supports the market for energy efficient products. It aims at making energy efficient products the first choice for consumers, by offering them a user-friendly tool for product comparison and selection. The key element is an online information platform for consumers presenting the most energy efficient appliances currently available in various product categories, including household appliances, office equipment, consumer electronics and cars. Information on energy consumption and performance of products as well as several other characteristics (i.e. brand, model, price, and picture) is provided. Product data is based on labels and standardized declarations as well as tests from accepted well-known institutions. The service is independent of manufacturers and retailers.

Consortium

The Euro-Topten project is co-ordinated by the Agence de l'Environnement et de la Maitrise de l'Energie (ADEME, France). The other 19 project partners are:

Project Partner	**Country**
Austria : Austrian Energy Agency	AT
Belgium: World Wide Fund for Nature – vzw/asbl	BE
Belgium: WWF European Policy Office	BE
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Criteria Paper for Tumble Driers

Contents

1 Introduction

The criteria papers provide a central tool for the national partners to collect and analyse product data and to establish a national Topten selection. Appropriate selection criteria and technical specifications are a crucial precondition for meaningful and well-accepted Topten websites. The purpose of this criteria paper is to provide a common basis for the definition of technical specifications of tumble driers. Within the European wide Topten project, an aligned approach for technical specifications for all national Topten websites is aimed at. A high level of uniformity and congruency of the different national websites will enhance the awareness amongst manufacturers. Good quality product data at national level furthermore allows to analyse the situation at European level and to make policy recommendations, which are shown on www.topten.eu.

This paper contains information for the product specification for Topten.eu qualified tumble driers, as well as suggestions for criteria for national sites. A product should meet criteria described in Chapter 4 in order to be Topten product. Hopefully this paper can be used as a guide in adding tumble driers in national websites.

2 Product Specification - overview on most relevant product types and characteristics

This chapter provides an overview of tumble driers in the market and drying technologies covered in this criteria paper.

2.1 Product Definition

There are two main types of tumble driers: **Vented tumble driers** and **condenser tumble driers**.

Vented tumble driers intake compartment air, possibly heat it, use it to dry the clothes inside the drum, and blow out the humid air through an exhaust pipe (to the atmosphere instead of back into the room).

Condenser tumble driers, with circulating airflow, process the amount of air available inside the drum only. They do not have an air exhaust pipe connection: the water, which is removed from the clothes, will either be collected in a reservoir or pumped into the drain as with washing machines.

2.2 Product Types

Vented tumble driers
In air vented tumble driers, heat is generated using electricity and resistors. Compartment air is heated by a heating element and forced through the laundry, dehumidifying it. The humid air is blown out to the atmosphere, so there is no necessity for a condensate reservoir or a drain. The best performing products for this technology only achieve a C energy class on the energy label.

Compact driers
Compact driers are prevalently air vented tumble driers with resistive heat generation, although condenser types do exist. From a technical point of view, they share the problems of their full-size counterparts. Furthermore, they are less energy efficient than full-size driers. Compact driers are generally much smaller and cheaper than full-sized appliances, making them interesting for a completely different segment of the market.

Gas tumble driers
Gas tumble driers work similar to electric air vented tumble driers, but the heat source is a gas flame. With the exception of heat generation, gas tumble driers consume electricity to rotate the drum, supply the control circuitry, etc. A gas port is needed to operate a gas tumble drier. Gas tumble driers have a rather small market share in Europe, contrary for example to the US, where they are widespread. Possible reasons for the difference are the lack of infrastructure, the requirement that the installation be carried out by a professional, and safety concerns on the part of the customer.

Condenser tumble driers

In condenser driers, the air is heated electrically as in an electric air vented drier. Yet, instead of blowing out the humid air once, it has passed through the laundry, the air moisture condensates in a heat exchanger. A heat exchanger is a device, which brings into thermal contact two media of different temperatures without mixing them. Heat is transferred from the hotter to the cooler medium. In current condenser driers, the hotter medium is humid air. Hot air can carry much more water than cool air. When the hot air is cooled, the moisture it carries condensates inside the heat exchanger, from where the water is removed by force of gravity and/or a pump into a reservoir or the drain. When the air has cooled down and dried, it is circulated through the electric heater again, and the cycle starts over.

Recently, some conventional (without heat pump; see below) condenser tumble driers have achieved a Class B Energy Label thanks to a combination of design features allowing improving heat and mass transfers in the drum, limit heat losses and energy waste at the end of the cycle.

Heat pump condenser tumble driers

The operation principle of heat pump driers is shown in Figure 2. The heating element and the humidity removing facility are the hot and cool sides of a heat pump, respectively (labelled “1”, in the bottom part of the Figure 2.). A heat pump generates heat on its primary side by compressing the working fluid (left, labelled “2”). The thermal energy is transferred to the air blowing through the laundry (middle, label “3”). That way, the working fluid cools down. On the second side of the heat pump, the cool working fluid is expanded (bottom right, label “4”). Due to the decreasing pressure, the working fluid gets colder. So does the secondary side of the heat pump, on which the water contained in the humid air condensates. The water is collected or drained. Once cooled and dry, the air is recirculated through the primary side of the heat pump.

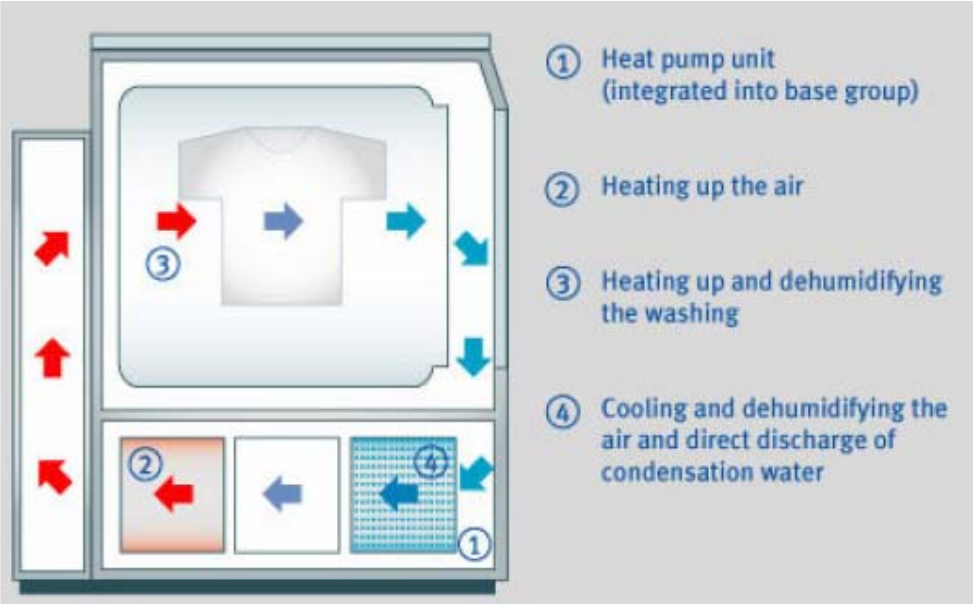

Figure 2. Heat pump tumble drier principle

Heat pump driers are the only technology to meet the class A requirement. The best models consume about 0.19 kWh/kg laundry, while the least efficient about 0.43 kWh/kg laundry (both at 60 % initial moisture). Thus, heat pump driers not only meet the A class requirement but the best models exceed it by far.

Although choosing between a class A and a class B model does not suggest much difference in efficiency for a user, there is a 50% efficiency gap between a typical heat pump drier and a conventional class B condenser drier [4]. However, the current models may have longer drying times. According to industrial sources, the drying times vary from 100 to 140 min on the market for 6 kg loads.

2.3 Best Available Technology

Only heat pump electric tumble driers can achieve the energy class A or better with a price twice as high as the price of vented or condenser driers mostly populated in class C.

Gas fired household tumble driers, currently a niche market, could achieve class A and beyond at a lower price but may not always be appropriate for end-users as they are only air vented and need appropriate installation including the availability of gas supply to dwellings.

High-efficiency heat pump driers have been on the European market for several years, and their market share is gradually increasing, although wide-scale market transformation has yet to be achieved (Niederberger, 2009). Switzerland is among the few countries where the energy efficient technology of heat pump driers has achieved breakthrough. The following figure 3 shows the sales share of heat pump driers in European countries in 2008 [2].

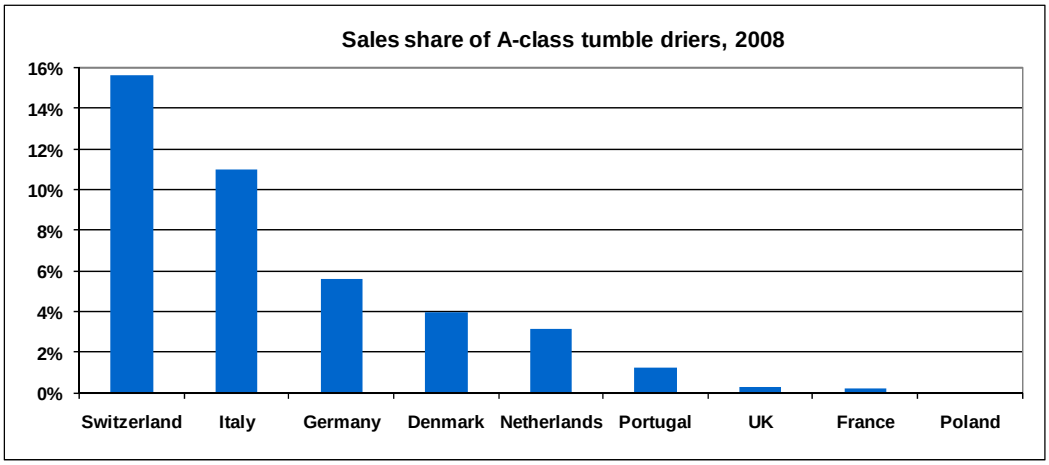

Figure 3. Sales share of class A models in 9 European countries in 2008 [2].

2.3.1 The Swiss experience

In 2003, Topten undertook the first tests of heat pump driers available on the Swiss market. Based on real-use feedback, Topten formulated user recommendations for driers. In 2003, Topten convinced the city of Zurich to choose only heat pump driers for its housing projects. In 2006, Topten convinced the power utility of Zurich (EWZ Elektrizitätswerk der Stadt Zürich) to offer consumers a rebate of up to EUR 200 upon purchasing a heat pump drier [5]. Since 2007, several other Swiss utilities and communities have launched rebate programs for heat pump driers [6]. As a result of these efforts, the market share of heat pump driers in Switzerland constantly increased, reaching 32% by 2010 (Figure 4).

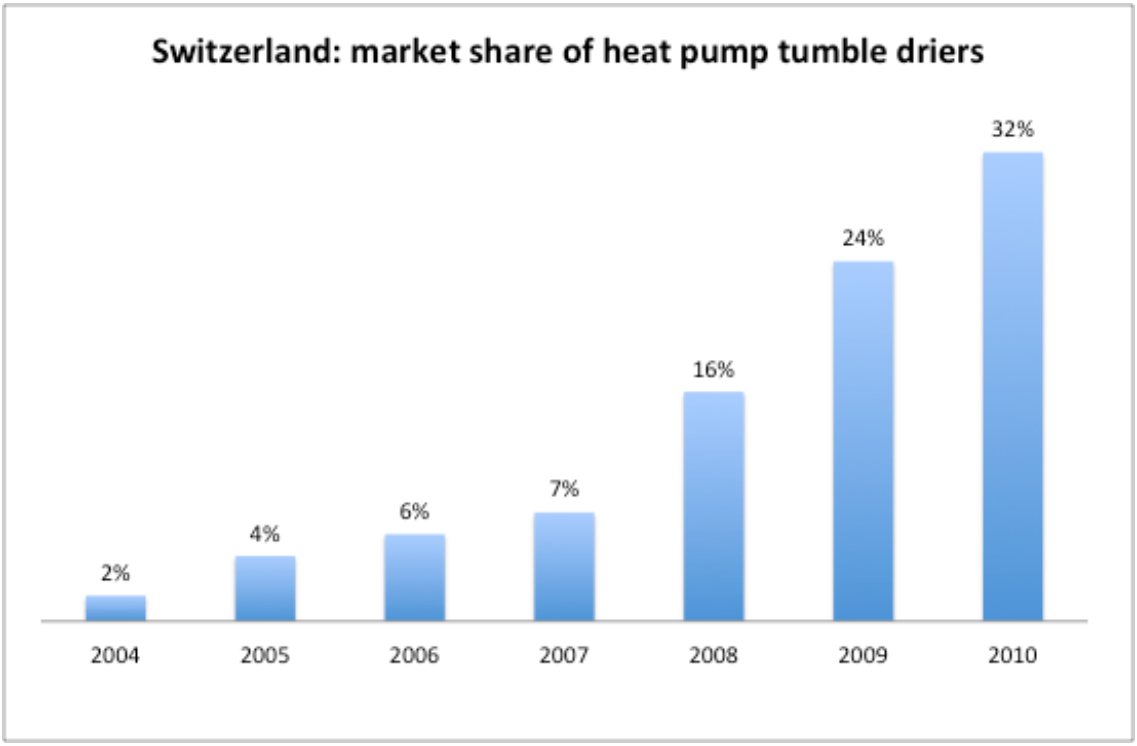

Figure 4: Sales share of class A driers sold in Switzerland [7].

Topten estimated the savings potential at 400 GWh/year, if all driers in Switzerland were replaced by class A driers [8]. Observing market developments and aiming to realize this potential, Topten, S.A.F.E. and Swiss ecological and consumer organizations had advocated setting minimum energy performance standards (MEPS) for heat pump driers. In 2009, the time was ripe. Swiss policy makers decided to ban all drier models below class A from the Swiss market, starting in 2012. Since 1st January 2012, only class A (heat pump) driers can be sold in Switzerland.

2.4 The Ecodesign-regulation for household tumble driers (draft)

As of December 2011 there are no set Ecodesign regulations for household tumble driers. The regulations have been drafted by the EU Commission (26.4.2011) [9].

The Ecodesign-regulation establishes Ecodesign requirements for the placing on the market of electric mains-operated and gas-fired household tumble driers and built-in household tumble driers, including those sold for non-household use.

In the impact assesment carried out on tumble driers, the option which appeared the most appropriate and which was also advocated by all stakeholders was to revise the energy labelling scheme and adopt ecodesign requirements in a coordinated approach.

The aim of the Ecodesign regulation is to phase out the least inefficient conventional driers in two phases: first to go are the today's lower class C and worse, (new proposed class D) from 2013, from 2017 the new proposed class C. This unfortunately does not mean a complete phase out of conventional driers; most of today's class B (new class C) driers would still be left on the market. The exclusion of washer-driers from the regulation can also undermine the measures, as experts expect a rise in the market share of washer-driers in the future [10].

The regulation sets minimum requirements for the condensation efficiency: a good things as low condensation efficiency can lead to wet rooms and the need for additional room drying equipment. The proposed condensation efficiency values of 60% (tier 1) and 70% (tier 2) may be too low (as suggested in the Topten Policy recommendations [10]) but they pave the way for better equipment.

For more comments on the regulation, see Topten Policy recommendations on tumble driers [10].

2.5 The Energy labelling of tumble driers

Household tumble driers are covered by *Commission Directive 95/13/EC of 23 May 1995 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric tumble driers* (OJL 47, 24.2.1996, p. 35) [11]. The still existing and relevant energy labelling of tumble driers is presented in 2.5.1. The draft for the revised labelling for tumble driers is presented in 2.5.2.

Background information on the changing energy labelling

The main reasons for the change in the energy labelling are a) ecodesign requirements and b) the outdated A-G scale of the energy labelling directive from 1995 (95/13/EC). Also the fact that new technologies have emerged since the first directive: heat pump tumble driers being the most significant.

Heat pump driers are the only technology with which energy class A can be reached. Unfortunately it is very difficult to make any distinctions between the different heat pump driers: as the energy efficiency index is not shown on the existing label, all heat pump driers are "just" A class.

The aim of the new energy labelling regulation is to introduce new, more ambitious, energy efficiency classes in order to adapt them to technological developments and introduce more dynamism into the scheme. The new label introduces – as do the other new labels – A, A+, A++ and A+++ -classes to the label. Energy efficiency index scales are the same for all types of driers (covered by the label) but the index is calculated differently depending on the type (condensating vs. vented drier).

2.5.1 Energy labelling of tumble driers (existing)

The still existing energy label for tumble driers [11] shows the following:

I. Supplier's name or trademark.

II. Supplier's model identifier.

I and II

III

III. The energy efficiency class shown with an arrow mark (energy efficiency class is determined by the energy efficiency index, separate scales exist for condenser and vented driers).

IV. A copy of the eco-label may be added here.

V. Energy consumption in kWh per cycle, for 'dry cotton cycle'.

VI. Rated capacity of cotton, in kilograms.

VII. The type of appliance, air vented or condensing, mark with an arrow.

VIII. Where applicable, noise measured in accordance with Council Directive 86/594/EEC. The noise declaration is voluntary.

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Energy efficiency scales for tumble driers

For tumble driers the energy efficiency scale is calculated using the cotton drying cycle with a maximum declared load. The energy efficiency index or calculated the energy consumption (c) is kWh per kilograms of laundry, measured according to the standards set in the directive [11].

Different scales apply for condenser and vented dryers.

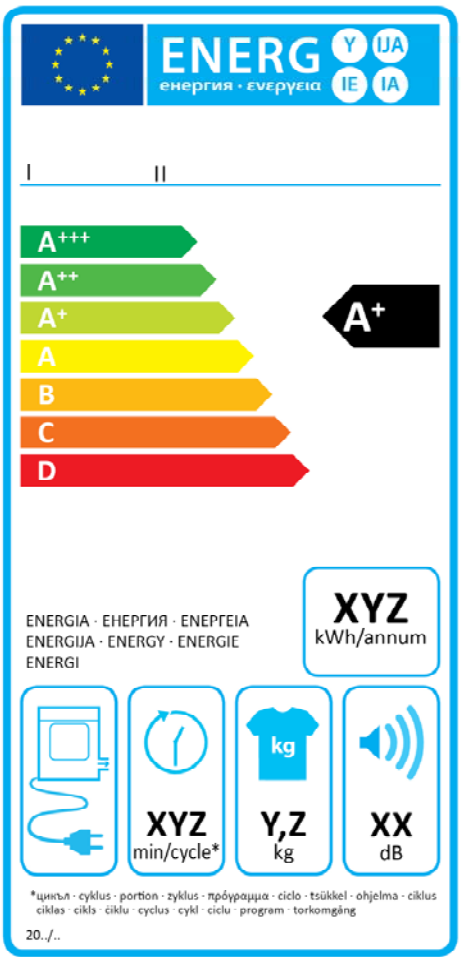
Vented driers		Condenser driers	
Energy efficiency class	**Energy consumption per kg of laundry**	**Energy efficiency class**	**Energy consumption per kg of laundry**
A (most efficient)	C ≤ 51	A (most efficient)	≤ 55
B	0,51 < C ≤ 0,59	B	0,55 > C ≤ 0,64
C	0,59 < C ≤ 0,67	C	0,64 < C ≤ 0,73
D	0,67 < C ≤ 0,75	D	0,73 < C ≤ 0,82
E	0,75 < C ≤ 0,83	E	0,82 < C ≤ 0,91
F	0,83 < C ≤ 0,91	F	0,91 < C ≤ 1,00
G (least efficient)	C > 0,91	G (least efficient)	C > 1,00

2.5.2 Energy labelling of tumble driers (draft)

Energy labelling of household tumble driers is being revised by the EU Commission, the following (2.5.2) presents the revised energy labelling according to the draft proposal (21.10.2011) [12].

The revised labelling suggest three of labels for three types of driers: air-vented, condenser and gas-fired. Energy efficiency classes are the same for all types, condenser type drier label shows also the condensation efficiency.

Label for air-vented household tumble drier (draft)



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Information included in the label for **air-vented** household tumble driers:

I. Supplier's name or trademark

II. Supplier's model identifier

III. The energy efficiency class

IV. Weighted annual energy consumption in kWh/year, rounded up to the nearest integer, based on 160 drying cycles of the standard cotton programme at full and partial load, and the consumption of the low-power modes. Actual energy consumption per cycle will depend on how the appliance is used.

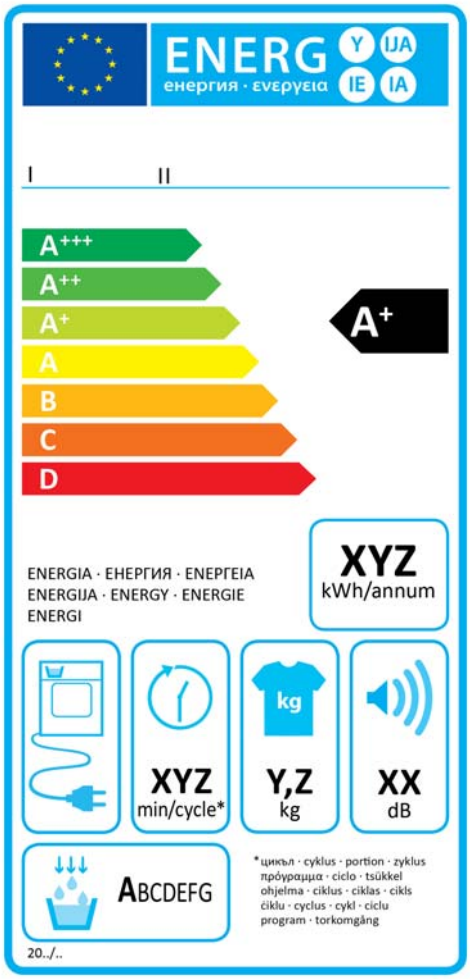
V. Information on the type of household tumble drier (air-vented, condenser or gas-fired).

VI. Cycle time corresponding to the standard cotton programme at full load in minutes and rounded to the nearest minute

VII. Rated capacity, in kg, for the standard cotton programme at full load

VIII. Airborne acoustical noise emissions, during the drying phase, for the standard cotton programme at full load, expressed in dB(A) re 1 pW, rounded to the nearest integer

Label for condenser household tumble drier (draft) [12]



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In addition to the information listed for air-vented driers, the label for **condenser** household tumble driers shall include

IX. The condensation efficiency class

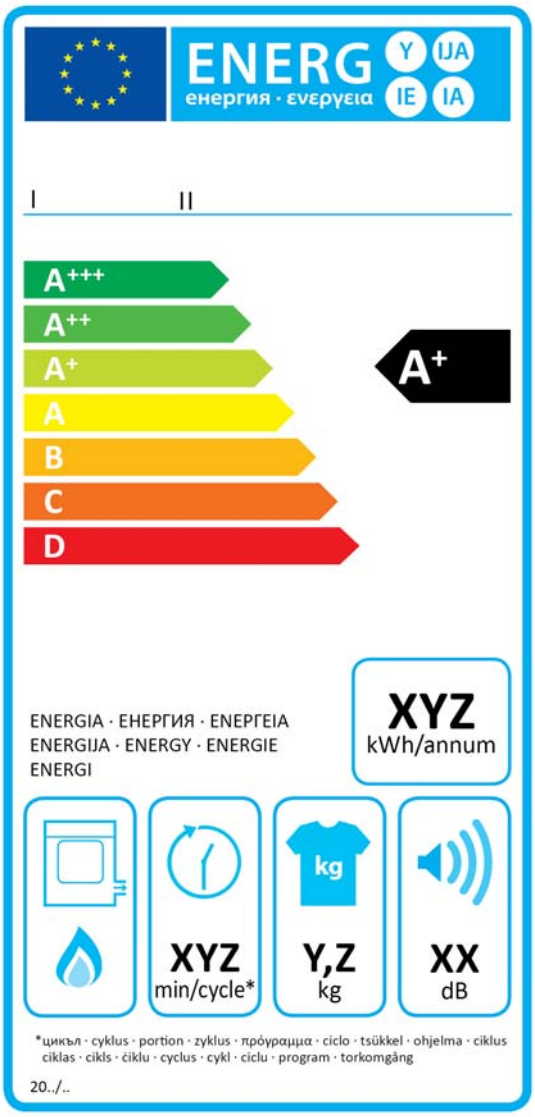
Condensation efficiency classes (draft) [12]
The condensation efficiency class of a condenser household tumble drier will be determined based on the weighted condensation efficiency (C_t) as set out in Table 1.

For calculating the weighted condensation efficiency, the average condensation efficiency for the standard cotton programme at both full and partial load is considered [12, see annex VII, point 2.].

Table 1: Condensation efficiency classes

Condensation efficiency class	Weighted condensation efficiency
A (most efficient)	C_t >90
B	80< $C_t \leq$ 90
C	70< $C_t \leq$ 80
D	60< $C_t \leq$ 70
E	50< $C_t \leq$ 60
F	40< $C_t \leq$ 50
G (least efficient)	$C_t \leq$ 40

Label for gas-fired household tumble drier (draft) [12]



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The information listed before for air-vented driers shall be included in the label for gas fired household tumble driers.

Energy efficiency classes (draft) [12]

The energy efficiency class of a household tumble drier will be determined based on its Energy Efficiency Index (*EEI*) as set out in Table 2.

For the calculation of the Energy Efficiency Index (*EEI*) of a household tumble drier model, the weighted Annual Energy Consumption of a household tumble drier for the standard cotton programme at full and partial load is compared to its Standard Annual Energy Consumption [12, see annex VII].

Table 2: Energy efficiency classes

Energy efficiency class	Energy Efficiency Index
A+++ (most efficient)	EEI < 25
A++	25 ≤ EEI < 35
A+	35≤ EEI < 45
A	45 ≤ EEI < 65
B	65 ≤ EEI < 76
C	76 ≤ EEI < 85
D (least efficient)	85 ≤ EEI

3 Market data

The following presents a short market data analysis of tumble driers in the EU.

The stock of tumble driers in the European Union (EU) was estimated at 41 million units in 2000. An increase of over 20 million units was estimated by 2010 (Figure).

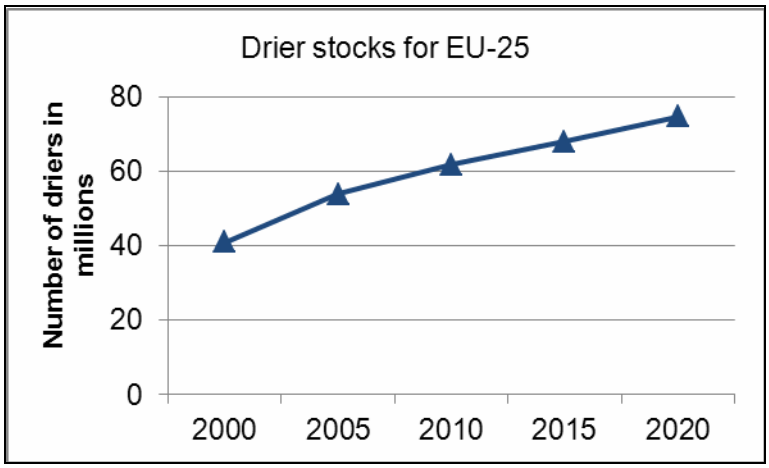

Figure 5. Drier stock development in the EU-25 [1]

Within the European stock, the share of the ten new Member States (Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia, Slovakia) is expected to grow from 0.3% in 2000 to 6% in 2020 [1].

This shows that there are significant differences in the penetration of driers between East and West. This also applies for the North-South relation. To give an example, the number of driers sold in a year is about the same in Italy as in Switzerland [2], although the population of the two countries differs significantly (in 2010: 60.5 million and 7.8 million respectively) [3]. In southern Europe, warmer countries, electrical drying is less important since the laundry can be dried outside in the sun during a longer period than in northern Europe.

In 2007, more than 3.8 million tumble driers were sold Europe-wide, of which 93% were electric tumble driers. The share of condenser driers was estimated to 60% in 2007. Industry experts confirmed that sales shifted towards condenser driers from air vented driers.

A trend of increasing size has been observed. The market has moved from driers with an average capacity of 4.5 to 5 kg to a loading capacity between 5.5 kg and 6 kg and in particular between 6.5 kg and 7 kg [1]. In 2011, the first 9kg-models heat pump driers have emerged on the market (topten.eu).

Today there is a vast market supply of 80 models from 17 different manufacturers and of different sizes, for household, semi-professional and professional use (see www.topten.eu) [10].

In 2005, 90% of driers sold on the European market were of energy efficiency class C. By 2010, the sales shares of heat pump driers rose sharply to over 30% in Switzerland and Italy and to over 20% in Germany according to expert opinions. In other countries sales shares remained low. [2]

Table 4: Sales by air technologies, in units [1]

Technology	Western Europe		Eastern Europe	
	Sales Units		Sales Units	
	2002	2005	2004	2005
VENTED	1 724 414	1 651 208	9 968	9 306
CONDENSER	1 632 564	2 017 068	18 234	28 933
UNKNOWN	NA	57	1 233	180
Total	**3 356 978**	**3 668 333**	**29 435**	**38 419**

Table 5: Sales by loading capacity, in units [1]

Load capacity	Western Europe		Eastern Europe	
	Sales Units		Sales Units	
	2002	2005	2004	2005
<= 4,0 kg	251 981	225 375	1 598	584
> 4,0 <= 4,5 kg	175 601	42 971	181	197
> 4,5 <= 5,0 kg	2 114 582	1 181 726	18 485	10 024
> 5,0 <= 5,5 kg	337	829	0	480
> 5,5 <= 6,0 kg	806 390	1 899 294	8 828	25 345
> 6,0 <= 6,5 kg	0	19	0	0
> 6,5 <= 7,0 kg	1 591	272 523	194	1 545
> 7,0 <= 7,5 kg	251	41 459	11	225
> 7,5 <= 8,0 kg	9	0	0	0
> 8,0 kg	4 743	2 200	24	4
UNKNOWN	1 493	1 936	113	16
Total	**3 356 978**	**3 668 333**	**29 435**	**38 419**

Table 6: Sales by energy efficiency classes, in units [1]

Energy efficiency class	Western Europe		Eastern Europe	
	Sales Units		Sales Units	
	2002	2005	2004	2005
A	13 318	16 957	17	178
B	3 742	17 758	1 209	76
C	2 661 650	3 288 241	26 505	37 176
D	409 658	213 100	844	703
E	15 360	12 789	35	10
F	107 480	93 461	0	0
G	20 233	1 374	0	0
UNKNOWN	125 536	24 653	825	276
Total	**3 356 978**	**3 668 333**	**29 435**	**38 419**

As seen in table three the sales figures show that nearly two thirds of the tumble driers sold in Europe are condenser type driers. Major part of the sales are products with a load capacity of less than 6 kg (table 5). There has been a slight increase in the sales of A and B class driers in Western Europe, but in Eastern Europe the sales have concentrate to C class (table 6). Noteworthy measures are needed to shift the sales from C class products to A class.

4 Concept and Criteria

4.1 Topten Europe

Topten Europe (www.topten.eu) lists the most energy efficient household electric tumble driers of Europe. The energy class according to the EU energy label must be A. In general, only heat-pump tumble driers meet this criteria.

Five tumble driers's categories are presented on Topten.eu:

- for residential use (driers designed for one apartment, 6kg load)
- for residential use (driers designed for one apartment, 7kg load)
- for residential use (driers designed for one apartment, 8kg load and more)
- For semi professional use (driers designed for several apartments, with a usage intesity about 5 times the usage of residential driers)
- Driers for professional use

Order of presentation

The products are presented according to their energy efficiency (energy consumption per load according to EU energy label). The presentation order can be changed by clicking on headings (brand, model, electricity cost etc).

Presented information:

- Brand and Model
- Price €
- Capacity in kg
- Drying time in minutes
- Energy class
- Energy Consumption (kWh/kg laundry)

4.2 Test Standards

The following standards are relevant for the assessment of tumble driers.

Reference / date	Title	Main points
EN 61121: 2005 IEC 61121 ed. 3.1: 2005 (A1:2005)	Tumble driers for household use – Methods for measuring the performance	Defines test methods for measuring performance of tumble driers as regards the: drying performance, evenness of drying, condensation efficiency (for condenser driers), water and electric energy consumption, programme time. Watch out: Measurements are based on an initial moisture content of 60. The current labelling scale still on 70% - multiplication with a factor of 1.14 is required to obtain the label class from the measured efficiency). The EN standard represents the basis of the current European energy labelling system for tumble driers.
EN 60704-2-4:2001, IEC 60704-2-4:2001	Household and similar electrical appliances. Test code for the determination of airborne acoustical noise. Particular requirements for washing machines and spin extractors	Relevant noise measurement standards
EN 60704-3 IEC 60704-3:2006	Household and similar electrical appliances - Test code for the determination of airborne acoustical noise - Part 3: Procedure for determining and verifying declared emission values	Relevant noise measurement standards

4.3 Tumble drier criteria for national Topten sites

In order to be displayed on Topten, tumble driers must meet the following criteria**:**

- Tumble drier energy efficiency class at least A (according to the existing energy labelling
    - o If there are no A class tumble driers in the market, the product group should not be promoted on Topten. For example, there is a 50% efficiency gap between a typical heat pump drier (A class) and a conventional class B condenser drier. Topten should not therefore promote heavy consuming products.

- If the suggested draft energy labelling comes into force, more distinctions can be made. As according to Topten Policy recommendations [10] the criteria can then be made stricter: for example A+ and better.
    - o Additional selection criteria can also be set for the condenser driers on the condensing efficiency.

4.3.1 Additional information

Additional product information displayed on Topten can give the consumer a more thorough outlook on the product. Additional prodct information is not additional selection criteria, but can give more wider view of the product. This and general information on the energy efficiency of tumble driers (4.3.2) can also be used on the recommendations for tumble driers.

- Does the drier have an electronic display, with:
    - o viewing of programme flow and drying;
    - o viewing of drying time;
    - o notifications for condenser unit and lint trap; and/or
    - o notifications for water dispenser?
- Does the drier have automatic alarms to to notify of the following;
    - o the need to empty the water dispenser;
    - o the need to clean the condenser unit (heat exchanger);
    - o end of programme; and/or
    - o programme flow-related disorders?

The consumers should be encouraged to familiarize themselves with the instruction manual of the product.

- The drier instruction manual should include a table of main drying programmes and their attributes, such as:
    - o suitability for different textiles
    - o load capacity
    - o drying time
    - o energy consumption
    - o residual moisture

- Instruction manual should also include information on:
  - cleaning the lint trap,
  - cleaning the condenser unit,
  - cleaning other elements of the product,
  - requirements for placements such as ambient temperature and moisture,
  - installation-related issues, such as electrical and water connections as well as any exhaust air requirements, and
  - energy saving tips for energy efficient use of the product.

4.3.2 Energy efficiency of tumble driers

The practical energy efficiency of tumble driers is also affected by the following issues related to device placement, use and management:

- **Efficiency of the washing machine spin cycle**: to ensure efficiency, washing machine should have A class spinning efficiency when using a drier.

- **Drier Type:** Heat pump drier function is currently the most energy efficient (energy efficiency class A). Roughly speaking, the heat pump operated tumble drier consumes 50 % less electricity as a conventional condenser tumble drier (existing C class).

- **Ambient temperature:** Electricity consumption of a condenser tumble drier could double if the room temperature rises above 30 degrees Celsius. This is important when placing a condenser drier: air flow from the drier can heat the ambient air and cause consumption to rise, especially in closed quarters (small rooms with inadequate ventilation).

- **Regular cleaning of the drier lint trap and condenser unit** is essential, because otherwise the air circulation is reduced and the drying time is longer and the energy consumption increases.

5 References

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