Heat Pump Tumble Driers: New EU Energy Label and Ecodesign requirements in Europe, MEPS in Switzerland, Initiatives in North America

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Abstract

Electric laundry drying is becoming increasingly popular in European households. Therefore, promoting efficient tumble driers[1] is essential to limit the increase in household energy consumption. Tumble driers with an integrated heat pump use only 50% of the energy a conventional electric condensing tumble drier uses. This year the European Union (EU) has introduced efficiency measures for tumble driers: since June 2013 the new EU energy label for driers is mandatory, and from November 2013 the Ecodesign regulation will apply, which contains requirements on the energy efficiency and condensation.

This paper will give an overview on Best Available Technology (BAT) in Europe according to the online search tool www.topten.eu for the most efficient drier products. This will allow for interesting conclusions including: Have the top classes of the EU energy labelling scale been designed appropriately? Will the label continue to exert an incentive for the manufacturers to develop more efficient tumble driers? Are the Ecodesign requirements stringent enough?

The market share of heat pump driers in the EU varies between countries but has been steadily increasing. In Switzerland heat pump driers are a success story! In January 2012 Switzerland imposed a minimum performance requirement that effectively allows the purchase of only heat pump driers.

The United States (U.S.) is also introducing new policies to promote efficient driers, and energy efficient technologies are poised to change tumble drier market. The article will conclude with recommendations for EU and US policies.

Introduction

Drying with an electric tumble drier in Europe is becoming more and more the trend. In the US using a tumble drier is the norm. However, these appliances use a lot of energy. Condensing driers with an integrated heat pump are a highly energy efficient technology. They use 50% less energy than conventional condensing systems. Thus it is worthwhile to promote this type of tumble drier and to push its market share.

The paper will give an overview on the main technologies of tumble driers, the European situation for driers such as market share, the new EU energy label, Ecodesign requirements, and the BAT

[1] The authors use in this paper the spelling «drier» as used in the European regulations and as opposed to the American spelling «dryer».

according to www.topten.eu. The focus then turns to Switzerland, which takes a leading role in pushing the market share of heat pump driers by its minimum energy requirements for all tumble driers. Finally we will have a look at the situation of driers in North America (the U.S. and Canada).

Technology of Tumble Driers

Two Main Systems: vented driers and condensing driers

Tumble driers evaporate the moisture by blowing hot dry air through the laundry. The air is heated up by the electric resistance heating element. There are two different technologies that exist to remove the evaporated water [1]:

1. Air vented driers (open systems): Blow the exhaust air (initially air from the room) outdoors and cause disturbing smells, steam and noise at the external outlet.

2. Air condensing driers (closed systems): Room air is cooling down the warm damp air from the wash by a heat exchanger and thus condensing the moisture.

Heat pump driers cut energy consumption by 50%

Heat pump driers are condensing driers which integrate a heat pump. Warm, damp air flows out of the laundry drum into the evaporator, where the air is dehumidified and the warm air returned to the drum.

Heat pump driers consume only about half of the electricity of conventional condensing driers. This makes them a highly efficient alternative to conventional systems. However, within the group of heat pump driers the energy efficiency varies quite a bit [2]. Due to the low temperatures heat pump driers treat clothes with care.

Heat pump driers have the lowest life cycle costs

As shown in Figure 1 heat pump driers have the lowest life cycle costs and from a life time investment perspective thus they should be the only choice. On the other hand, as also shown in the Figure 1, they (still) have a higher purchasing price than conventional driers, which might be a purchase barrier especially for consumers from struggling economic countries. Another aspect of heat pump driers that must be noted, the cycle time in general is longer than with conventional condensing driers.

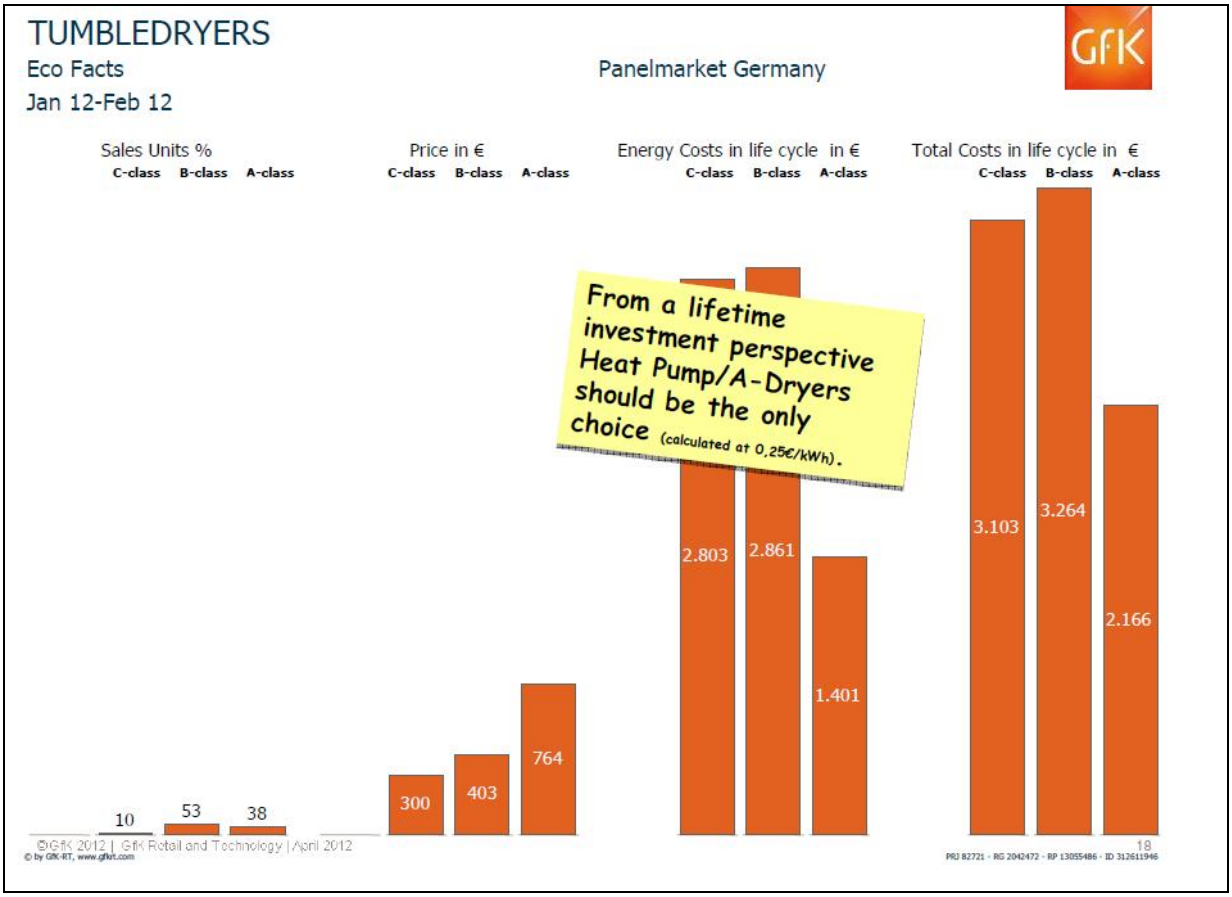

Figure 1: Tumble driers. Eco facts. January – February 2012. Panelmarket Germany. Outer left: Sales Units % C-class to A-class; Left: Price in Euro C-class to A-class; Right: Energy Costs in life cycle in Euro C-class to A-class; Outer right: Total Costs in life cycle in Euro C-class to A-class. (Source: GFK 2012 (Anton Eckl): Home Appliances – Markets with Strong Fundamentals).

Market situation of Tumble Driers

In Europe, heat pump driers are gaining market share

The market penetration of household tumble driers in Europe is steadily on the rise. Four million tumble driers were sold for residential use in Europe in 2010. The stock is estimated to be about 54 million appliances. However, the level of market penetration is uneven across European countries. For example, more than 60% of Dutch homes have tumble driers, while they appear in less than 20% of Italian homes. The dominant tumble drier technology in Europe still is conventional condensing [3].

In general it can be said, that heat pump driers are gaining market share in Europe. However, the sales share of the energy efficient alternative «heat pump driers» varies in the EU between countries. Concerning the market share of heat pump driers Switzerland is leading (for details see chapter below), but it is also high in Germany, Austria and Italy (around 40%).

In 2012, around 90 residential heat pump drier models from 18 different manufacturers were available on the European market [4].

80% market penetration of tumble driers in North America, but no heat pump driers on the market yet

In North America, dryers have reached market saturation and can be found in over 80% of U.S. and Canadian homes [3]. Recent laboratory research in the U.S. has documented that European HP driers use only half (50%) of the electricity of conventional, vented (non-condensing) US driers.

However, despite these potential energy savings, no HP driers are currently sold on the North American market and consumer and retail awareness is virtually non-existent. The Super Efficient Dryer Initiative (SEDI) is working to bring more efficient driers to the U.S. and Canadian markets [3], [5]..

Regulations in Europe

New EU Energy Label for Tumble Driers since June 2013 is mandatory

After a transition period of one year, where the old [6] and the new EU energy labels [7] could co-exist, the new EU energy label is now mandatory since June 2013. Revisions to the label include:

- Introduction of the energy efficiency classes A+, A++ and A+++: With the old EU energy label, all heat pump driers were placed in the energy efficiency class A. This although within the group of heat pump driers there exist considerable differences concerning their energy efficiency. The EU was aware of this fact and designed a new EU energy label for tumble driers. The introduction of the energy efficiency classes A+, A++ and A+++ was made to allow the distinction between more and less efficient heat pump driers. With the new EU energy label the classes A to A+++ are all reserved for heat pump driers.

- Introduction of the Energy Efficiency Index (EEI): With the old EU energy label the energy efficiency classes were based on the energy consumption (kWh) per kg of laundry. The new EU energy label calculates the EEI in a different way. The base for the calculations are for 160 standard cycles which take into account the energy consumption at full and partial load, left-on/off-mode and programme (calculation details see Annex II of [8]).

- Introduction of the «condensation efficiency»: With the new EU energy label a classification for the condensation efficiency was also introduced. The classes range from A (most efficient) to G (least efficient). This parameter is key because low condensation efficiency can lead to humid rooms and the need for additional room drying equipment and therefore an increase in the need for electricity consumption.

- Declaration of the cycle time: It is declared how many minutes the drying cycle lasts.

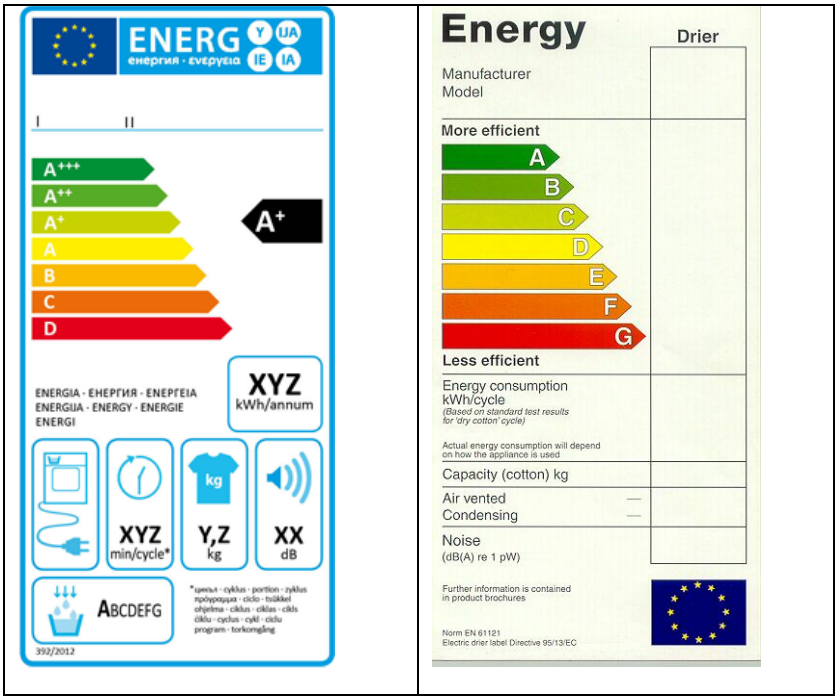

Figure 2: Left: New EU energy label for tumble driers (mandatory since June 2013). Right: Old EU energy label for tumble driers.

Ecodesign Requirements for tumble driers from November 2013

According to the Ecodesign regulation following the Minimum Energy Performance Standards (MEPS) will be required for condensing driers [8]:

	Energy Efficiency Index EEI	**Condensation Efficiency**
From November 2013 (Tier 1)	< 85 (equals class C and better)	> 60% (equals class D and better)
From November 2015 (Tier 2)	< 76 (equals class B and better)	> 70% (equals class C and better)

Table 1: Ecodesign requirements for condensing driers [8].

As Table 1 shows, condensing driers with class D and below will be phased out in 2014, from 2016 on condensing driers with class C and below will be phased out[2]. In other words: non-efficient appliances with a class B (they have no heat pump) will be available on the market in the future.

Until 2016 it will be allowed that up to 40% of the moisture can be expelled into the room (condensation efficiency of 60%), from 2016 on only a range up to 30% will be allowed.

Best Available Technology (BAT) of Tumble Driers on the European Market

www.topten.eu gives an overview on the Most Energy Efficient Tumble Driers in Europe

An overview of the most energy efficient tumble driers available on the European market is presented by the Topten site «Best Products of Europe» www.topten.eu [2, for Topten see box below].

In order to be listed on www.topten.eu, tumble driers must meet the following selection criteria (July 2013):

- Energy efficiency: A++ or A+++ according to the new EU energy label.
- Condensation efficiency: B or A according to the new EU energy label.

As Figure 3 shows, best performing models on www.topten.eu use between 172 kWh to 259 kWh of electricity per year (according to the declaration of the new EU energy label).

- The best EEI is 23.2.
- The threshold for A+++ is 24.
- The two 7 kg appliances reach both the energy efficiency class A++. One of them reaches the condensation efficiency class A, the other class B.
- From the ten 8 kg models, three models reach the energy efficiency class A+++, whereas two models are placed in the condensation efficiency class A, the other one only reaches class B.
- Seven 8 kg models reach the energy efficiency class A++. Three of them are classified A concerning the condensation efficiency, four models are places in the condensation efficiency class B.

[2] Class C vented driers will remain on the market in tier 2, due to a different Energy Efficiency Index EEI calculation formula.

- The three models with a capacity of 9 kg all reach the energy efficiency class A++ and the condensation efficiency class A. The drying time at full load reaches from 145 minutes to 200 minutes.

Topten will add more models as soon as the data is available from the manufacturers. Topten also will strengthen the criteria according to the development of the market.

Brand	Siemens	BEKO	AEG	Siemens	Siemens	Siemens	Brandt
Model	WT48Y7W1	DPU 8306 GXE	T97689IH T97685IH	WT48Y701	WT48Y731	WT48Y781	BFD82CH
Electricity costs (€ 15 years)	387	396	398	479	479	479	490
Capacity (kg)	8	8	8	8	8	8	8
Drying time (min) full load	187	174	188	186	186	186	180
Energy class	A+++	A+++	A+++	A++	A++	A++	A++
Energy (kWh/year)	172	176	177	213	213	213	218
Condensation class	B	A	A	B	B	B	A
Efficency Index	23.2	23.3	24	28.4	28.4	28.4	29
Countries available	on demand	on demand	DE / on demand	on demand	on demand	on demand	CH / on demand

Gorenje	Gorenje	Electrolux	AEG	Electrolux	BEKO	AEG	AEG
D 8565 H	D 7565 NA/NB D 7665N	EDH3498RDL	T59880	EDH3497RDW	DPU 8305 XE	T86589IH3	T86594EIH
490	448	583	477	583	522	526	583
8	7	9	7	9	8	8	9
180	155	165	155	180	145	170	200
A++	A++	A++	A++	A++	A++	A++	A++
218	199	259	212	259	232	234	259
A	A	A	B	A	A	B	A
29.2	29.6	30.3	30.7	30.8	31.1	31.8	32
on demand	on demand	SE / on demand	DE / on demand	SE / on demand	on demand	DE / on demand	DE / on demand

Figure 3: Screenshot www.topten.eu: the most efficient tumble driers for residential use on the European market (July 2013), 7 kg, 8 kg and 9 kg capacity, energy consumption as declared at 60% initial moisture (according to EN 61121:2005).

Topten

International online search tool for the most energy efficient products on the market

Topten is an international online search tool which presents the most energy efficient products on the market such as household appliances (e.g. heat pump driers), office equipment, consumer electronics, building components, lamps and cars. It aims to accelerate market transformation towards energy efficient products, while creating a dynamic benchmark for the most efficient technologies. The selection criteria are described transparently. They are primarily based on the EU energy label, but depending on the product group additional criteria may be required. Topten is neutral and independent from manufacturers.

topten.info

Topten is online in Europe, China and the U.S.

The first Topten site appeared in Switzerland in 2000 (www.topten.ch). Since then it has travelled the world and is online in 18 European countries, China (www.top10.cn) and the U.S. (www.toptenusa.org).

Best Products of Europe on www.topten.eu

The «Best Products of Europe» are presented on www.topten.eu. The site also formulates recommendations for EU policy makers.

topten.eu

Success Story of Heat Pump Driers in Switzerland

100% market share of heat pump driers in 2012

In Switzerland, the sales share of heat pump driers has steadily risen since 2004. Figure 4 shows that heat pump driers (class A, green bars) reached a market share of around 25% in 2009, 32% in 2010, and 47% in 2011. In 2012 the market share went up to 100%. This is due to the introduction of the Swiss Energy Regulation for tumble driers [9].

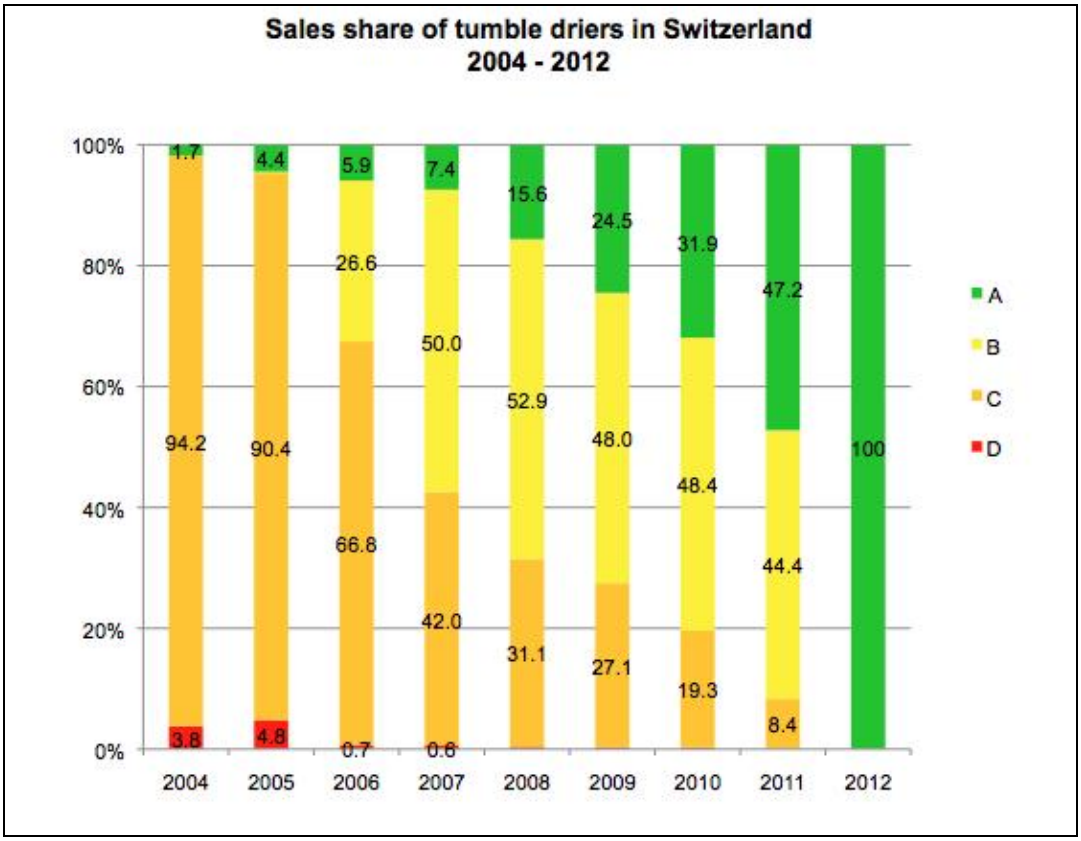

Figure 4: Sales share of tumble driers in Switzerland 2004 – 2012. Energy classes according to the old EU energy label [6]. Class A (green bars) are heat pump driers. (Source: [10])

Swiss Energy Regulation only allows heat pump driers on the Swiss market

In the framework of the Swiss Energy Regulation [9] Switzerland introduced Minimum Energy Performance Standards (MEPS) for tumble driers. This allows only for the sale of heat pump driers on the Swiss market. The requirements have been in force since January 2012. In other words, non-efficient tumble driers are completely banned from the Swiss market. This also explains why the market share of heat pump driers rose to 100% in 2012 (see Figure 4).

With its strong requirements, Switzerland is a pioneer and is leading the way with transforming the market. The success of this was in part due to the pressure by Topten and partners from Swiss environmental organisations, the city of Zurich and Zurich's utility (ewz), who closely worked together to promote and push the market introduction of heat pump driers in Switzerland (e.g. by rebate programs).

Feedback from manufacturers and consumers is positive!

The stringent requirements for tumble driers in Switzerland showed its first impact:

- The requirements work well for the manufacturers: Although the number of drier units sold in Switzerland has come down by 5%, the turnover increased [10]. Thus, there was no economic disadvantage for the manufacturers.
- The requirements are great for the consumers: heat pump driers yield high savings on their electric bill.

Initiatives in North America

SEDI is in the works to bring heat pump driers to the market

The Super Efficient Dryer Initiative SEDI, launched in 2010 by the New Jersey Clean Energy Program, brings together drier manufacturers, government agencies, utilities, and appliance retailers in the U.S. and Canada to promote the introduction of new, energy efficient and advanced tumble driers into the North American market. Since its launch, SEDI sponsorship has expanded to include thirteen energy efficiency programs across the U.S. and Canada [11].

A testing program for heat pump driers has been carried out

Programs and governments must have high-quality data on the energy savings that can be expected from heat pump technology before providing this support in North America. SEDI benefits from European experience and has tested the energy consumption of currently available European heat pump driers to North American conventional electric dryers to better understand the potential for energy savings if this technology were introduced into North America [12].

Main findings are:

- European heat pump driers use only 40-50% as much energy as North American conventional driers to dry the same amount of laundry.
- But also European heat pump driers take twice as long to dry a load of laundry as North American conventional driers.
- Further modifications to the new DOE test procedure, including the use of a test load that more closely represents real-world clothing, are needed to more accurately predict March 2013 actual drier energy consumption.
- The recently proposed 2013 revisions to the DOE clothes drier test procedure include automatic termination – a significant improvement from the current 2005 test procedure.

Energy labels for tumble driers are in preparation

Due to the lack of more efficient technology options on the North American tumble drier market, tumble driers in the U.S. have never carried energy efficiency labels. The ENERGY STAR programme has not covered tumble driers yet, and the U.S. Federal Trade Commission has not implemented an Energy Guide label for this product group [3]. The only North American energy label for driers is the EnerGuide label which is issued by Natural Resources Canada for products sold there. However, the situation with labels is about to change.

ENERGY STAR Emerging Technology Award

In 2012 the EPA announced the ENERGY STAR Emerging Technology Award for Advanced Dryers. The Emerging Technology Award is a relatively new initiative for ENERGY STAR which recognizes new, promising energy efficient technologies which are not yet established on the market. On June 12, Samsung Electronics became the first manufacturer to receive the Emerging Technology Award for Advanced Dryers for their DV457 model. In order to meet the requirements of the Award, Samsung's drier must use about 30% less energy than the average conventional US drier, and be available for sale in the U.S. Although the expectation was that Award winning driers would likely use heat pumps or other significantly different technologies, the Samsung DV457 is a vented, resistance electric drier that uses improved controls and heat and air flow modulation to reach the Emerging Technology Award efficiency target.

Heat pump driers are not yet adapted to the needs of the North American market

In North America appliances are quite different than the European ones. For example, in the U.S. the voltage is 110 Volt (Europe: 230 Volt), the frequency is 60 Hz (Europe: 50 Hz), drier size is slightly larger although the capacity (of clothes than can be dried) are similar compared to Europe (see Figure 5). The programme duration of drying cycles also tends to be much shorter than in Europe.

The challenge for SEDI over the next two years is to help reconcile the desire of North American energy efficiency programme providers for a new technology with significant savings and the desire of the appliance industry, the ENERGY STAR programme and possibly also North American consumers for more modest, interim steps on the path to market transformation. Any successful super efficient drier for North America must be designed for the local market, and laundering habits.

The US Environmental Protection Agency (EPA), which administers the ENERGY STAR programme, has released a preliminary draft of a technical specification for a U.S. (potentially also Canadian) ENERGY STAR label for clothes dryers. This draft proposes minimum efficiency requirements that are about 15% above the average for current, conventional, vented electric tumble driers sold in the U.S. This level would also be significantly less efficient than a typical European HP drier.

Figure 5: Drum size difference: European drier (left) and North American (right) drier [12].

No rebate programs for tumble driers yet

Until now no rebate programmes have been carried out to promote high efficiency tumble driers. Feedback from some of the utilities in the U.S. is that a barrier to entry for heat pump driers is that European models are too small in size and would be too expensive to purchase compared to current drier models.

Conclusions and Recommendations

Europe

EU Energy label

In Europe, it is foreseen that the energy classes A to A+++ of the EU energy label are reserved for heat pump driers. This makes it possible a differentiation between efficient and less efficient heat

pump driers. It is no surprise that there are already A++ driers available at the time of the introduction of the new EU energy label (see www.topten.eu). But some have already reached the A+++ class indicates that the thresholds of the classes seem to be too low. Some heat pump driers also already meet the top class for condensing efficiency A. When designing new classes the best class should be kept empty for future developments. Otherwise a result might be that manufacturers do not have enough incentive to improve the technology.

Therefore it is recommended that the EU energy label for tumble driers should be updated in a timely manner to reflect the fast changing market. The new energy efficiency classes are weak, it is necessary to revise the EU energy label as soon as possible to facilitate further improvements. The top classes should then be held empty for future technical developments.

Ecodesign requirements

The requirements for tier 1 and tier 2 of the Ecodesign regulation for tumble driers do not seem ambitious enough. Non-efficient tumble driers will also be allowed on the market in the future. The requirements for the condensation efficiency also seem to be weak, taking into account what is already technically possible (class A and B, see the BAT according to www.topten.eu).

Therefore it is recommended that within the next revision of the Ecodesign regulation the future MEPS be more stringent for tumble driers regarding energy efficiency as well as condensation efficiency. The goal should be that only best performing appliances – heat pump driers – shall be allowed on the European market.

Good example: Switzerland

With the market for tumble driers having changed significantly in Switzerland due to the introduction of the Swiss MEPS, the feedback from manufacturers and consumers has been positive. The market stayed stable, sales are going well and considerable energy savings are being realized.

The example of Switzerland shows, that the introduction of stringent requirements for tumble driers is possible and brings a win/win-situation. The example should be followed by the EU.

North America

ENERGY STAR

Market push of existing tumble drier technology with ENERGY STAR is expected to bring efficiency improvements of about 15%. It now appears that improved conventional tumble driers will be capable of reaching ENERGY STAR. In the future, the label should be designed to set a more ambitious efficiency target. Improvements of test standards, labels and more research are important to enable a smooth development of new technologies.

ENERGY STAR Emerging Technology Award

The ENERGY STAR Emerging Technology Award brings an improvement of about 30% over conventional North American driers. It is recommended that future awards be designed to only be reached by driers with heat pump level efficiency.

Market introduction of heat pump driers

The current market environment in North America lacks market pull for heat pump driers. If there are no additional subsidies or market support for driers at the 50% efficiency improvement level or higher,

there will be little reason for drier manufacturers to introduce heat pump or other super efficient technologies to the North American market.

Therefore market introduction of heat pump driers needs special efforts. Policies are needed to give manufacturers incentives to develop heat pump driers adapted to North American market needs and consumer expectations. SEDI, ENERGY STAR and energy efficiency programmes are working to assist a successful market introduction, and to support the manufacturers in their endeavors. Programmes that run rebate programs should assist in educating and to successfully overcome the market barriers (e.g. higher purchase price) by promoting best performing appliances. Rebate programmes should be decided now, to enable long-term planning for the manufacturers.

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