Promotion of energy-efficient heat pump dryers

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Abstract

Drying laundry with laundry dryers is becoming more and more popular. Electricity consumption by dryers will therefore increase considerably in the near future. The promotion of energy efficient heat pump dryers helps to strongly lower this effect. Heat pump dryers cut energy consumption of conventional dryers in half and exceed the energy label A threshold by far. According to market data from 2008, heat pump dryers did not reach the break through yet and achieved a market share of less than 4% in most European countries. The situation in Switzerland however is promising: the market share of heat pump dryers has grown continuously since 2004, and reached 15,6% in 2008, and surprising 11% in Italy). The product range is growing: today there are 11 models for residential and 3 for semi-professional use on the Swiss market. The introduction to the Swiss market was facilitated by Topten and its partners, among them the City of Zurich, which could be convinced to launch a procurement program for heat pump dryers as well as a rebate program. Besides subsidies and information, one of the most important policy recommendations for the promotion is the revision of the EU labelling scheme. Today the energy label does not represent the fact that heat pump dryers – efficiency class A – are twice as efficient as conventional condenser dryers, especially since conventional dryers with energy label B are on the market. The label however should make perceptible to consumers the high efficiency of heat pump dryers – therefore a review of the dryer labelling scheme is urgent. We submit specific suggestions.

Introduction

Important energy consumption of laundry dryers

Drying laundry by conventional tumble dryers needs two to four times the energy needed to wash the same amount at 60℃. This is due to the physical fa ct that the water has to be evaporated by thermal energy to permit removal in the form of humid air. Water removal by spinning in a washing machine, powering the spinning motor, needs about 100 times less energy than thermal drying.

Considering the market penetration of laundry dryers in European countries (fig. 3), the actual trend to current and intensive use of dryers may raise substantially the respective energy consumption. A conventional tumble dryer thus may become one of the top electricity consumers in a household when drying all wash by this appliance.

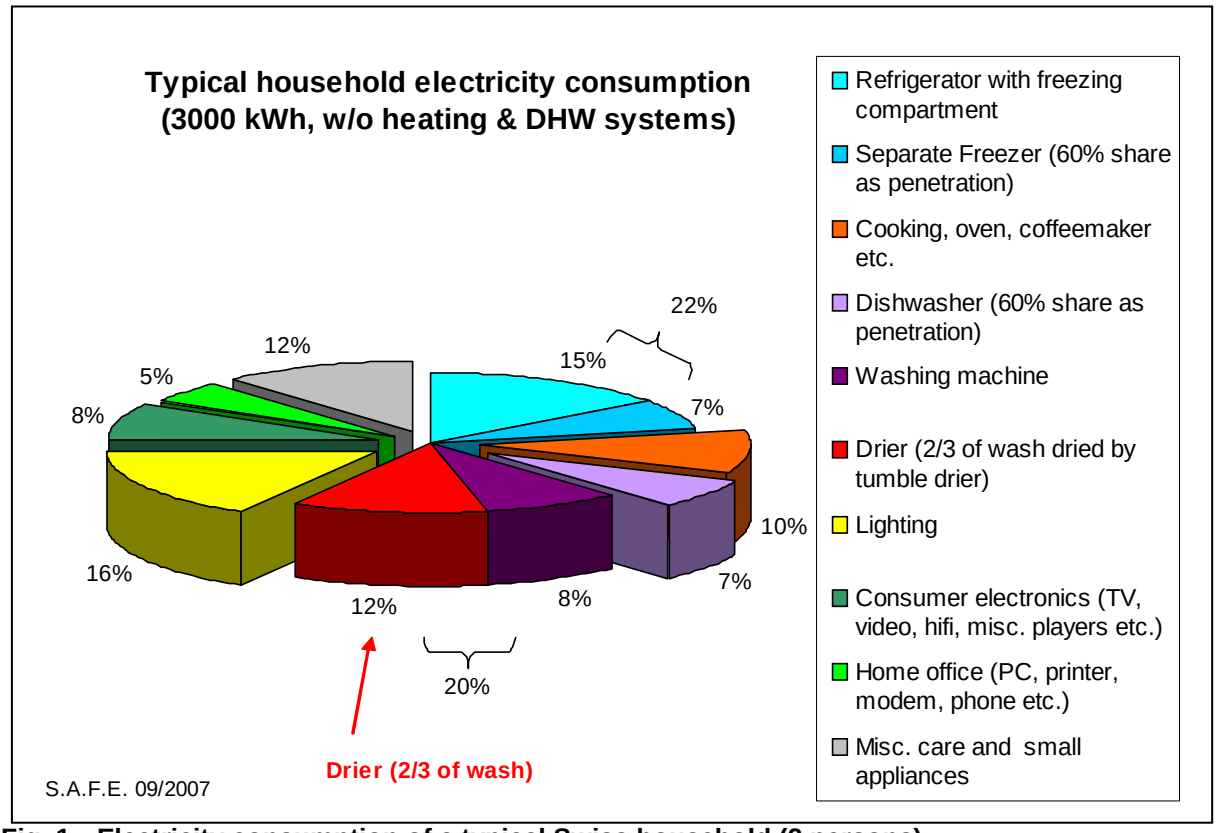

Fig. 1 Electricity consumption of a typical Swiss household (2 persons)

In households without dishwasher and separate freezer, and if more than 2/3 of wash is treated, the dryer share of household consumption can be significantly higher.

Ecodesign of laundry dryers – EuP preparatory studies

In the framework of the European Directive on Eco-design or Energy-using Products (EuP) laundry dryers were taken up into the second round of product categories als lot 16. A consortium with PriceWaterhousCoopers (PWC) as leader worked out preparatory studies according to the EuP method; reports are being published on www-ecodryers.org [1]. In 2008, reports on tasks 1 to 7 were published and a final stakeholder meeting held in December. The task 8 report will propose measures and policies; its publication was expected when closing this paper.

Heat pump dryers were treated in task 6 (technical analysis and Best Available Technologies BAT) and task 7 (improvement potential). Their energy saving potential comes out clearly, but the economics (pay back) prove to be critical because of the higher purchase costs.

Heat pump technology cuts consumption in half

Technology

Conventional dryers evaporate the moisture by blowing hot dry air through the wash, the air heated up by electric resistance heating. They use two different technologies to remove the evaporated water:

Air vented dryers are open systems. They blow the exhaust air (initially air from the room) outdoors and cause disturbing smells, steam and noise at the external outlet. If one wants to avoid this,

expensive exhaust air ducts over the roof are necessary. Air vented dryers need compensation air to be supplied by an opening. In winter this causes a cooling down of the room.

Air condenser dryers are closed systems. Room air is cooling down the warm damp air from the wash by a heat exchanger and thus condensing the moisture. At room temperatures above 30℃ the condensing efficiency is declining.

Water condenser dryers have very high water consumption and are therefore no longer sold on the market.

Heat pump dryers (fig. 2) combine a condenser dryer with an integrated heat pump, making them a highly efficient alternative to conventional systems. 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. They consume only about half of the electricity of conventional condenser dryers: Their efficiency exceeds the EU A-label threshold by far, while conventional (resistor heating) machines are typically B or C-class at best.

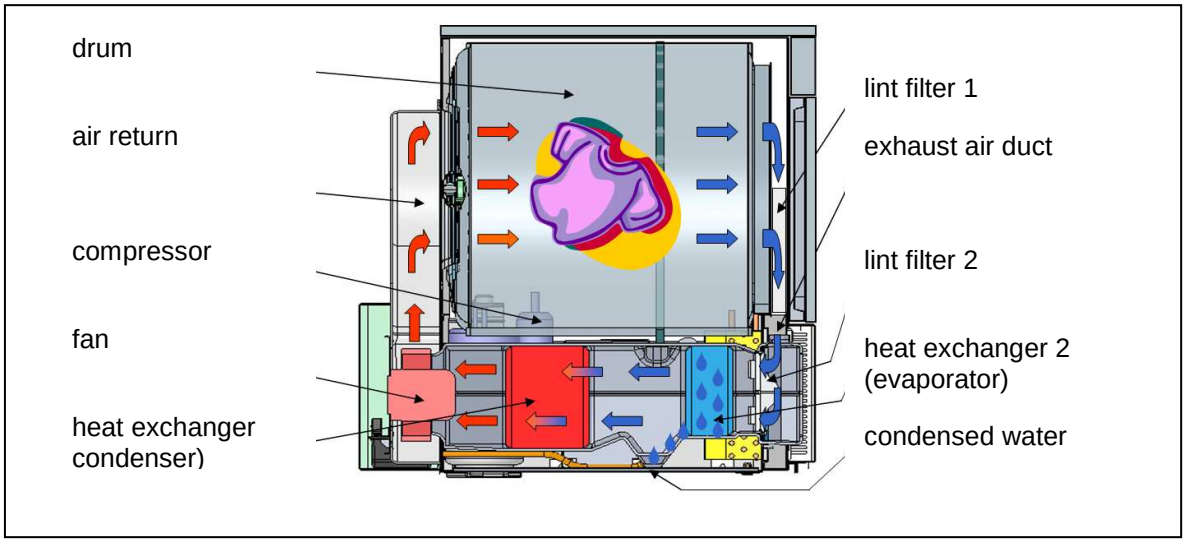

Fig. 2 Heat pump dryer, schematic of function

Picture source: Schulthess AG, Switzerland

Further efficiency potentials for heat pump dryers

The market offers of the past years show quite an interesting development of efficiency figures: starting well above 0,3 kWh/kg (at 60% initial moisture, EN 61121) – except a semi-professional model 0,28 – today several models yield 0,28 or 0,27 kWh/kg and, on the other hand, a cheap model with 0,43 kWh/kg is available.

From a technological view, the following principles can raise the overall efficiency of heat pump dryers and give room to stronger efficiency requirements (Minimum Energy Performance Standard MEPS, see below):

- Improve temperature levels by a heat exchanger air-to-air which transfers energy from the warm exhaust air after the drum to the cold air after the evaporator. Realised in a Swiss semi-professional heat pump dryer and a Swiss case heat pump dryer. Requires significantly more space.
- Compressors with permanent magnet motors (EC-motors). Realised in new very efficient air conditioners with EEI above 5 (www.topten.ch > Haus > Klimageräte).
- Fan and drum drive with EC-motors.
- Optimised heat exchangers (may claim more space than usually available).

Further advantages of heat pump dryers

Besides the huge potential in energy savings heat pump tumble dryers create further advantages compared to conventional condensing dryers:

- Wasted heat in the operation room is about 50% lower, what is very welcome in summer and even extends the possible operation hours in hot periods (as conventional condensing dryers hardly work at temperatures above 30℃).
- Compared to air vented dryers, there is no smelling and steaming exhaust air as with conventional air vented dryers. In winter, there is no cooling down of the operating room as caused by compensation air for vented dryers.

Market penetration and trends

Tumble dryers in general

Market penetration of tumble dryers by country for parts of the EU-15 was mentioned in an EMA_E Business Intelligence study for 2005, fig. 3. Actual data referring to individual countries are not published. EuP Lot 16 studies, task 2 [2] says that ownership rates and sales numbers in "new" EU countries are very low compared to EU15.

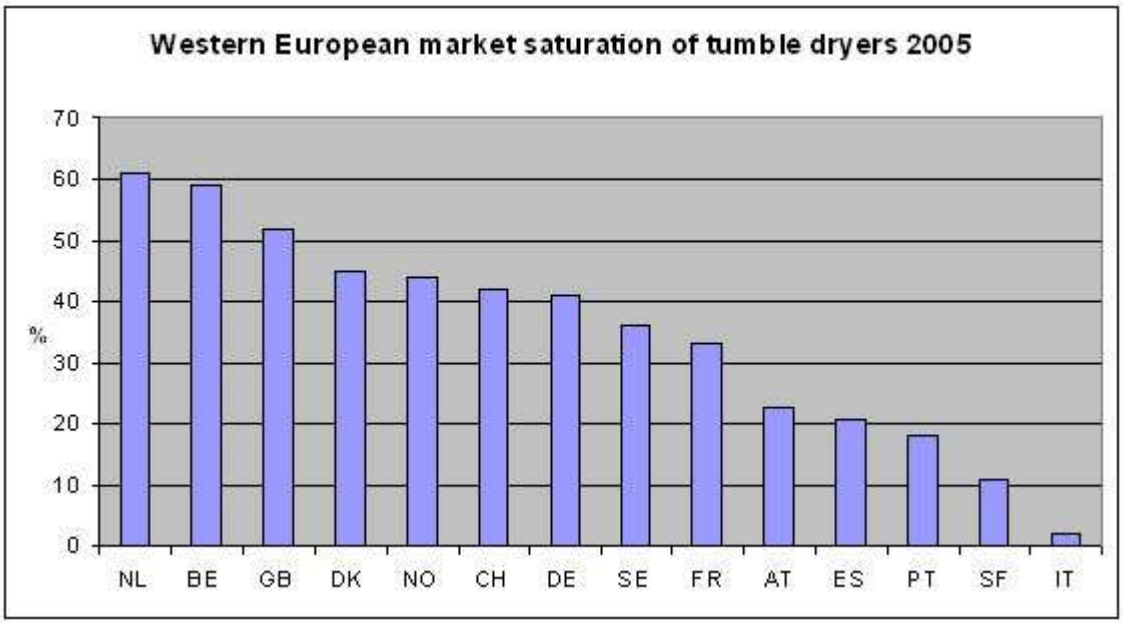

Fig. 3 Market saturation, examples 2005

Data source: EMA_E Business Intelligence estimation

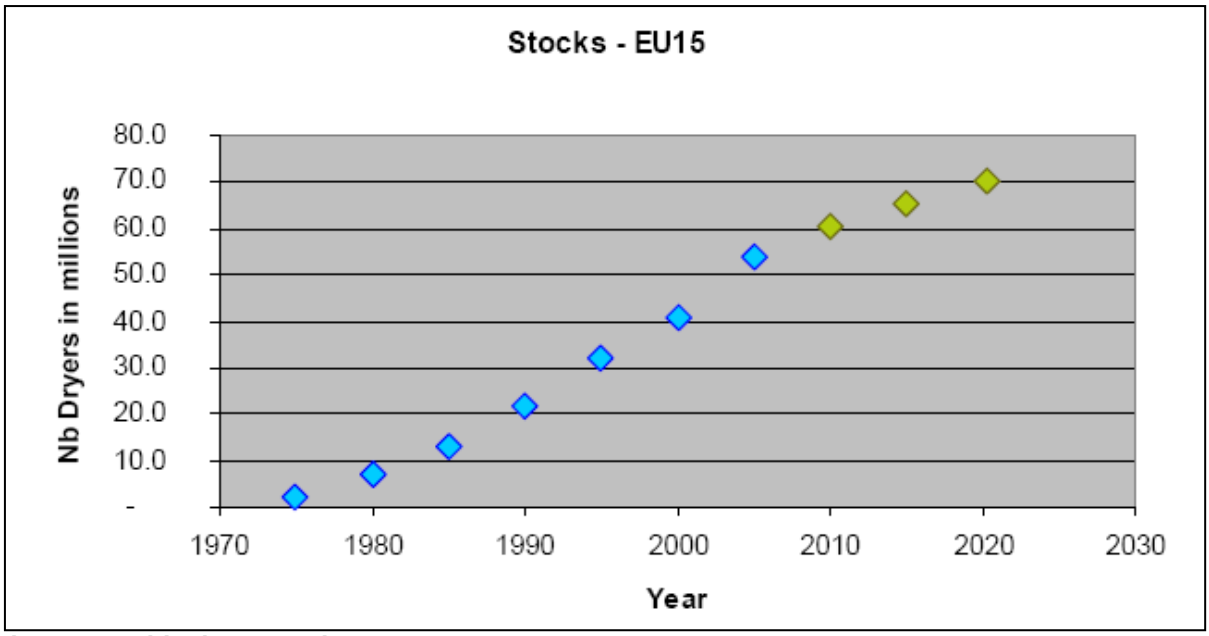

Fig. 4 Tumble dryer stock EU15

Fig. 4 (source: [2]) gives an impression of the total number of tumble dryers stock in EU and expected growth. For "new incoming" countries the following development of stock is estimated: 1,4 million in 2010, 4,5 million in 2020. This would hardly change the order of magnitude of the numbers in fig. 4. Sales figures according to [2] are close to 4 millions in 2006 and 3,8 million in 2007.

A very rough estimation of usage pattern (cf. EuP Lot 16 [3]) assuming 600 kg dryed wash per year (considering shared appliances) at a specific energy consumption of 0,7 kWh/kg and 60 millions of dryers results in 25,2 TWh per year. The consumption of gas fired dryers can be neglected. Topten standard value for residential use of dryers is 800 kg / year (applicable for mid and northern European countries.

The actual trend towards greater market penetration of tumble dryers (fig. 3) is a result of various factors, including the fast pace of modern life-styles with little time for extensive housework, insufficient space for line drying and air pollution. Despite high energy prices, sales and use of laundry dryers are increasing. Efficiency gain of dryers is indispensable in order to restrict drying energy consumption; heat pump dryers stand for a significant success in drying technology.

Heat pump dryers

Actual sales figures show a very promising raise of the heat pump dryers share in some countries. In Switzerland, this trend started some years ago (fig. 5). But also in other European countries, the market share of heat pump dryer is rising (fig. 6).

Since 2003, many detail questions concerning heat pump driers have been clarified in Switzerland. Among others, laboratory tests of all models available on the Swiss market were carried out and the consumer satisfaction in the everyday life was analysed [4]. The throughout positive experiences with heat pump driers convinced the city of Zurich. Since 2003, the city of Zurich officially favours heat pump driers and has put in place in 2005 a rebate programme to promote heat pump driers and thereby their wider introduction on the market on national level (see below).

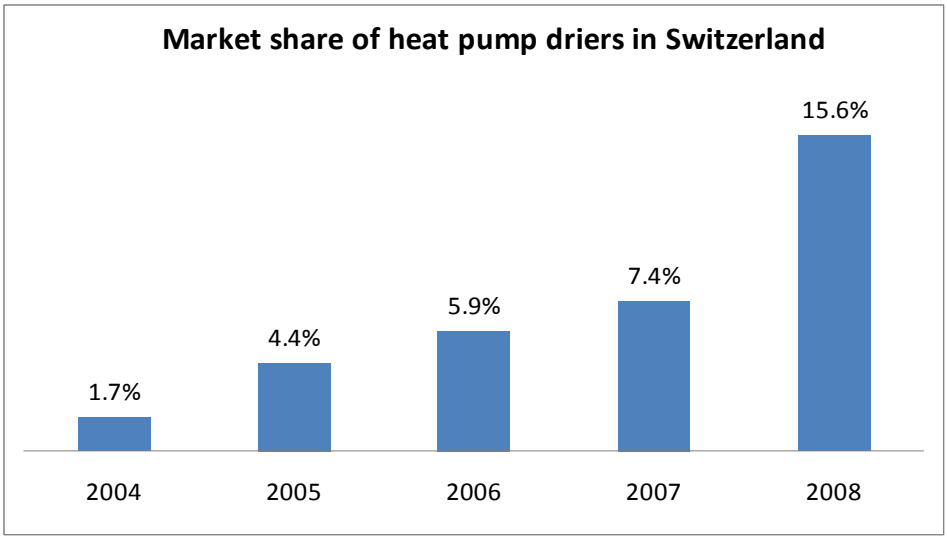

Fig. 5 Market share of heat pump dryers in Switzerland

Data source: FEA

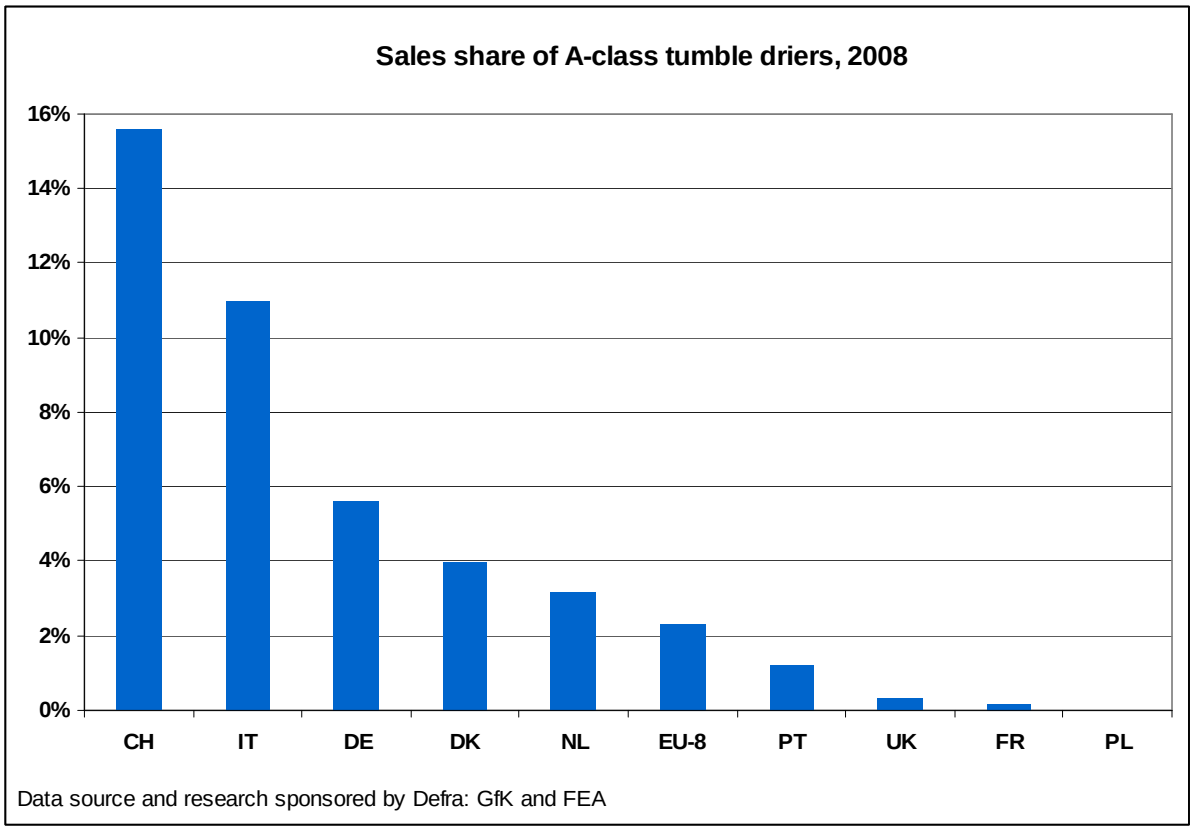

Fig. 6 Comparison of market shares of heat pump dryers

Data source and research sponsored by the UK Department for Environment, Food and Rural Affairs (Defra): GfK and FEA.

Obstacles and remedies

Economics

Heat pump dryers contain more and expensive components compared to conventional dryers, what causes higher manufacturing costs and therefore a higher purchase price. Actual market data give hope that heat pump dryer prices are moving downwards; a (not very efficient in comparison) product is offered at less than 800 Euros. Obviously, the economic gain for semi-professional use is very clear, while for residential (individual household) use only the cheap but not very efficient model yields a good gain (fig. 7). Energy savings of about 50% and ecological gains of heat pump driers are not affected by smaller economic savings in residential use.

In order to calculate the cost over life time, the following assumptions were taken:

- sales prices: 70% of the list prices (to account for Swiss pricing practice), except cheap residential model: list price
- electricity consumption in accordance with standard consumption values of the EC label, during 15 years
- residential use: 800 kg / year and 12'000 kg / 15 years; semi-professional use: 5'000 kg / year (approx. 20 wash courses per week) and 75'000 kg / 15 years
- electricity tariff: € 0,15 per kWh (EU27 in first semester 2008: 0,16)

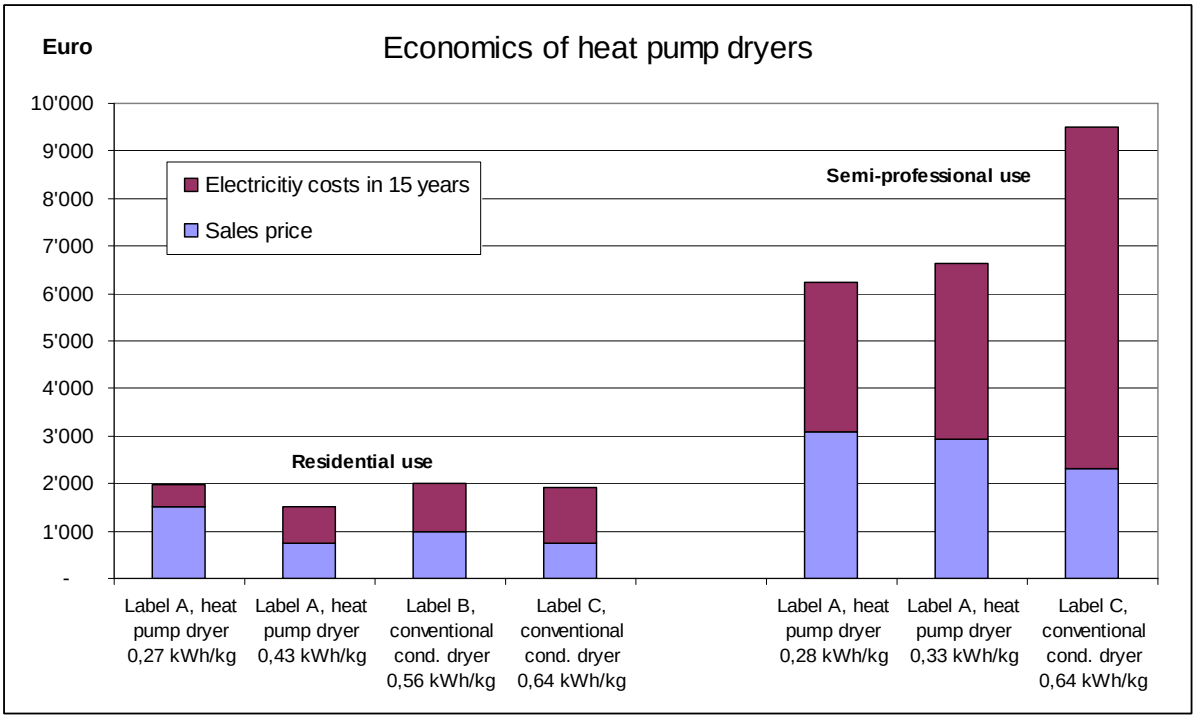

Fig. 7 Economy of heat pump dryers, residential and semi-professional use

Source: www.topten.info, actual market data

As most buyers are not used to consider life cycle costing (LCC), they prefer the cheaper product. Lack of knowledge about LCC seems to be the most important obstacle to the dissemination of heat pump dryers. The remedy is not simple: most publicity of the retailers tends to focus on lowest purchase prices, while LCC is more complex to communicate, and future gains (by energy cost savings) seem to be much less attractive than momentary rebates. Therefore subsidies and rebate campaigns have proved successful in fostering heat pump dryer sales.

Subsidies

As the significantly higher purchase price of heat pump dryers seems to be the predominant obstacle to the dissemination, particularly for residential appliances, subsidies or rebates come forward as the best remedy. The rebate campaign of the city of Zurich, first launched in 2005, is very successful, considering the total number of household customers of 200.000 (of which only a very small fraction needs a new drier in a year):

Subsidised dryers, ewz (Elektrizitätswerk der Stadt Zürich, utility of the city of Zurich), Oct. 2005 till Dec. 2008

- Residential dryers, number 716 Euros 133.000
- Semi-professional dryers, number 641 Euros 224.000

The survey of subsidies data issues most of these dryers to be initial purchases, while only a small share is for replacement. Nevertheless, the promotion campaign was noticed very well also by professional landlords, and the ewz personnel communicated the advantages of heat pump dryers in many consultations of customers.

Besides the direct incentive for the individual buyer, an important indirect influence on the market can be observed: retailers and manufacturers refer to the subsidies in their publicity, other communities and utilities tend to copy such campaigns for their own image, buyers and users communicate their (hopefully) positive experience to others.

Requirements for building equipment

Some countries know standards for new buildings or refurbishment that include requirements for building equipment and even appliances. The Swiss MINERGIE® label (www.minergie.ch) actually recommends class A appliances, but the advanced MINERGIE-P® certificate requires class A, including laundry dryers. The standard SIA 380/4 (Swiss Engineers and Architects Association) "Energy in Buildings" stated already in 2006 class A dryers as benchmark. Recommendations and also benchmarks from renowned technical organisations have an important information impact.

Information and publicity

Missing information on the availability of such energy efficient products may be another obstacle, which is actually diminishing, as more and more retailers offer heat pump dryers and dedicate some publicity. Public and consumer organisations should intensify the information work on the subject.

www.topten.info [5] presents an overview on all models of heat pump driers (energy label class A) in the European market. Furthermore it provides recommendations for policy makers.

An important obstacle in publicity actions is the actual energy label classification, which suggests a small difference between conventional condensing dryers reaching class B and heat pump dryer of class A. The label can not visualise that huge efficiency gap of about 50%, while the step between C and B is only about 15%. Consumers may therefore appreciate "B" as fairly efficient. To overcome confusion the scheme should be shifted as to represent this difference. The new classification scheme would also give manufacturers incentives to further improve the efficiency of dryers.

Review of labelling scheme, MEPS

Labelling scheme EC 1996

Fig. 8 visualises the dryer energy labeling scheme of the EC Directive 95/13/EC [6], which refers to 70% initial moisture of the wash, as stated by IEC 61121. In Dec. 2005 an update of the 61121 was published as DIN EN 61121:2005 [7], allowing measuring and declaring of energy consumption and

efficiency at 60% initial moisture, as washing machines achieve at common spinning speeds of about 1000 rpm. DIN EN 61121:2005 encloses a correction calculation scheme to get 70% (initial moisture) values out of the now measured 60% values. For condensing dryers this is simply a factor 1,14 (only condensing dryers are of interest in comparison to heat pump dryers).

Evidently the actual energy label classification according to EC Directive 95/13/EC leads to misunderstandings, when buyers get dryer offers of class A, B and C dryers and do not know the scheme figures. The label can not visualise the efficiency gap of about 50% from B (conventional condensing) to A (heat pump).

In fig. 9 we suggest two versions of new labelling schemes as a remedy to that problem. Version "new 1" realises a shift of 2 steps, which results in several available tumblers in class "A", while version "new 2" with 3 steps shifting yields no model in class "A" at present. The most efficient dryer we know (2008) is a Swiss heat pump drying case at 0,26 kWh/kg [8], which might be tuned down to 0,24 kWh/kg when exploiting the tolerances according to DIN EN 61121:2005.

Looking forward to further development potentials we plead for the "new 2" labelling scheme, which leaves space to classify new excellent dryers in A. If the general labelling scheme will be opened to more efficient models (numbered classes A1 etc.), the scheme "new 1" may also be reasonable, yielding several models in class A at the beginning.

Of course the labelling scheme for vented dryers would also have to be reviewed. There may remain a relative difference to the "condensing" figures as it used to be. Not being the subject of our work, we resign to make quantitative suggestions.

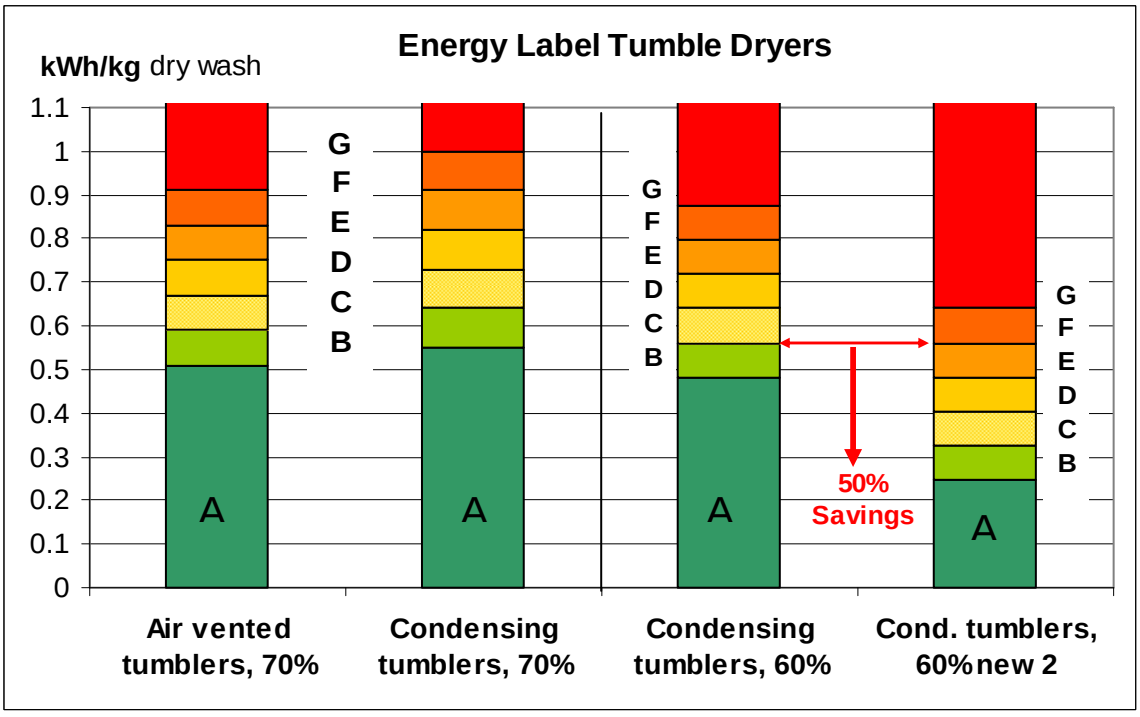

Fig. 8 Energy Label for tumble dryers, EC 1996 (70% initial moisture), condensing tumblers 60% and update suggestion "new 2"

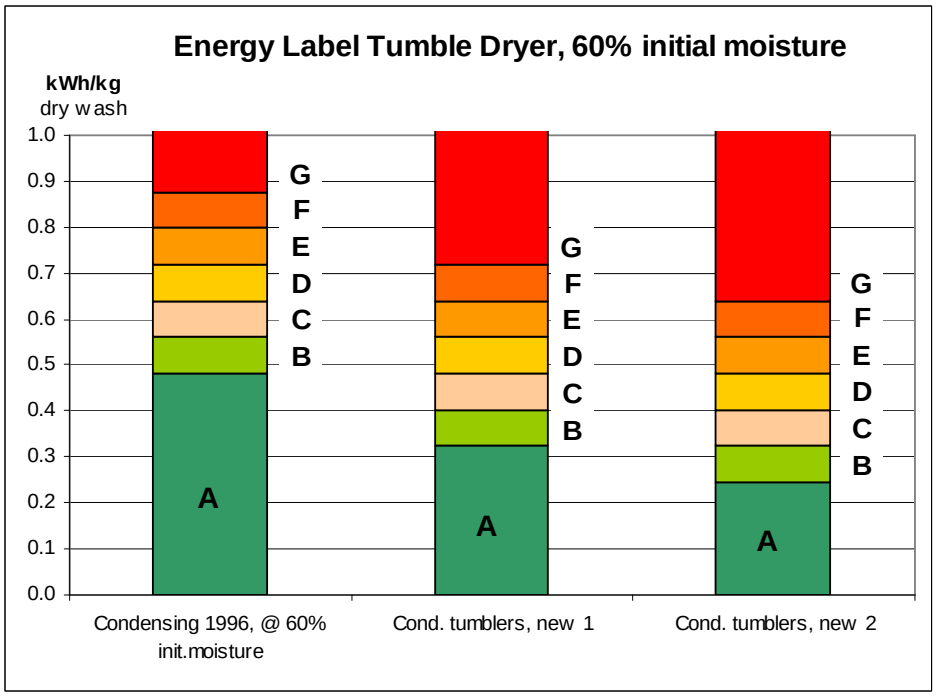

Fig. 9 Energy Label for condensing tumble dryers, EC 1996 and suggestions for update

The specific energy consumption values of fig. 9 refer to 60% initial moisture of the wash, while the "official" EU label scheme (Directive 95/13/EC) refers to 70%, cf. fig. 8 and text above.

Minimum energy performance standards MEPS

The preparatory studies of the Ecodryers team will consider suggestions for MEPS in the work of task 8, scenario-, policy-, impact- and sensitivity analysis (publication expected when closing this paper).

The situation for MEPS for laundry dryers is very special: as there is a large gap between the best conventional dryers (resistor heating, consumption > 0,55 kWh/kg, 60% initial moisture, EN 61121) and heat pump dryers (majority < 0,35 kWh/kg, 60% initial moisture), it would not be future-orientated to set MEPS so that conventional technology fulfils. On the other hand, prescribing the new heat pump dryers means to quit the "bad but simple" old technology. A good compromise seems to be to set strong MEPS (class A), but concede a long delay, giving industry time to develop and launch the "new generation".

The Swiss government and its Federal Office of Energy make an effort into the efficient future: they propose to set labeling class A as a minimum efficiency performance standard (MEPS) for laundry dryers from 2012 onwards. The ordinance (to the energy Law) is actually in the consultation process with a deadline for contributions of Feb. 13th 2009. The consolidation of the ordinance may take ½ to 1 year until in force.

If the proposition of the ordinance is accepted, this means that only heat pump dryers would be on the Swiss market in a few years. Switzerland has already a relatively high share of heat pump dryer sales (fig. 6), and a high share of flats with joint washhouses and semi-professional appliances, where highly efficient models are very economic, see fig. 7. These are good reasons to set strong MEPS for that appliance category. It is difficult to judge the chance of being accepted. Innovative manufacturers/ vendors will likely welcome that help to sell more efficient technology.

Conclusions

Heat pump tumble dryers represent a huge energy saving potential. Furthermore, they offer more convenience as wasted heat in the operation room is significantly lower compared to air condenser dryers, and there is no smelling and steaming exhaust air as with conventional vented dryers. The technology proved to be reliable, prices are diminishing, and further efficiency potential is visible.

Because of the higher purchase price and most buyers hardly used to life cycle costs evaluation, promotion by subsidies and by information on long-run profitability come out as primary and simple measures. Life cycle energy cost figures are published on www.topten.ch and www.topten.info for many years. We suggest further supporting measures as follows:

- Revision of the EU labeling scheme for tumble dryers. Heat pump dryers are much more efficient than the actual energy label class A threshold. Many conventional condensing dryers reached class B in the last years, thus appearing nearly as good as A despite consuming twice the energy. To overcome that confusion the scheme should be shifted as to represent this difference. A new classification scheme would provide an incentive for manufacturers to further improve the efficiency of heat pump dryers.
- Dissemination of basic information and procurement recommendations on heat pump dryers for energy agencies and other relevant bodies. The individual countries should create strategies, promotion programs and campaigns according to their specific situation.
- Launch of an international competition for the most efficient condenser laundry dryer – accounting for overall economic and ecologic benefits. Different categories with respect to capacity and/or intensity of use could be considered.

References

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[8] www.topten.ch/index.php?page=trockenschranke