Changing washing machines and driers: Let's have a look at the laundry room

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Abstract

In 2007, washing machines accounted for 6 % of the residential electricity consumption of the European Union (EU-27). In 2005, there were 167 million units of washing machines installed in the EU-25. In 2010, the stock of residential tumble driers was estimated at 62 million units, and is expected to grow. In North America, 80 % of the households already have a tumble drier. Electric tumble driers account for 7-8 % of the electricity usage in Canadian and American households that have them. Both in Europe and North America, there is room for efficiency improvements.

The scope of this paper is to highlight key developments in the markets for washing machines and tumble driers in Europe and to show how the positive experience of a successful market transformation initiative has provided an impetus to start similar efforts in North America.

In Europe, an updated energy label and the Eco-design requirements for household washing machines entered into force at the end of 2010. The EU energy consumption measurement standards for washing machines are currently under revision. For tumble driers, an update of the EU energy label is under way, but no Eco-design requirements are foreseen yet. In the USA the release of a new energy consumption test procedure for driers will allow better assessment of energy efficiency, and can support future policy initiatives such as an ENERGY STAR label for driers.

The most energy efficient tumble driers currently available use an integrated heat pump and only consume about half of the electricity of conventional condensing driers. Heat pump driers are the only ones that reach the "A" class under the current EU energy label scheme.

In Switzerland, the first heat pump drier appeared on the market in 2000. In 2009, the market share of A class (heat pump) driers reached 25 %. The market share of heat pump driers is increasing in other European countries as well (Italy, Germany). 2012, the Swiss government will require all driers sold in Switzerland to carry the A rating, effectively banning conventional driers from the market.

In North America the Super Efficient Dryer Initiative (SEDI) was recently formed to learn from the European experience on driers and to bring together energy efficiency programme providers, drier manufacturers, governments, utilities and other stakeholders to support large improvements in drier energy efficiency. The first tests of heat pump driers undertaken in the USA show an energy reduction potential of 40-50 % compared to the average conventional North American model, in line with previous Swiss test results.

The paper outlines a successful market transformation focusing on the importance of appropriate policy tools and the fruitful cooperation of different stakeholders.

Introduction

Clothes washing is an essential part of modern hygiene and good health. For many of us it is routine to run a washing machine, and more and more often a drier, at the end of the day.

Over the past few years, both the level of energy efficiency and the market penetration of energy efficient washing machines and driers have increased. In Europe, the regulatory framework has evolved including the enforcement of new regulations for washing machines. Decisions concerning driers are expected soon. In the USA a process to revise test procedures for driers was begun in 2009 resulting in the release of a new procedure in January 2011. These policy initiatives now allow a meaningful comparison between the performance of European and North American products.

This paper focuses on the energy consumption and energy efficiency aspects of washing machines and driers. New washing appliances, such as steam cleaners and home dry cleaning, and their energy implications are out of the scope of this paper as these types of laundry appliances still play a minor role in domestic sales at the present time. We first present the European situation for both washing machines and driers (regulation, key parameters influencing energy efficiency, best appliances on the market) and then present the situation for driers in North America, with a focus on a comparison between European and American driers, their efficiency and differences in related consumer habits.

Definitions

A household washing machine ("washing machine") is understood to be an automatic appliance designed to be used principally for non-professional purposes and which cleans and rinses textiles using water. Washing machines are also assumed to have a spin function for water extraction (Commission Regulation (EU) No 1015/2010).

A household tumble drier ("drier") is an appliance in which textiles are dried by tumbling in a rotating drum through which heated air is passed (Directorate General for Energy 2010).

Regulations in Europe

EU ENERGY LABEL

Revised EU energy label for washing machines

The current EU energy label is based on a tripartite classification scheme where energy efficiency, washing efficiency and spin-drying efficiency are rated with a single letter. The regulations governing the current EU energy label for washing machines were updated in December of 2010 and the new EU energy label must be shown on appliances after December 2011 (Commission Delegated Regulation (EU) No 1061/2010). During a transition period of one year, the current and the new EU energy label may coexist. The new EU energy label presents a number of differences compared to the current version:

- In order to better reflect the use of washing machines in homes, the Energy Efficiency Index, electricity and water consumption and the remaining moisture content are calculated on the basis of a mix of standard cotton programmes: 3 cycles at 60 °C full load, 2 cycles at 60 °C half load and 2 cycles at 40 °C half load (current label: 60 °C full load only).
- The number of energy efficiency classes will shift to from A+++ to D. The current range of classes is A to G. (There is furthermore an unofficial A+ as a result of a voluntary agreement between CECED manufacturers (European Committee of Domestic Equipment Manufacturers), see below.)
- The current label estimates washing machines' energy consumption based on energy consumed during the wash cycle. The new EU energy label focuses the annual energy consumption including also off-mode and left-on mode (standby), for 220 standard washing cycles per year.
- Energy consumption will be indicated in kWh per year as opposed to kWh per cycle.
- Water consumption will be indicated in litres per year as opposed to litres per cycle.
- Rated capacity will be indicated in kg when fully loaded at 60 °C or at 40 °C, whichever is lower. The current EU energy label states capacity in kg only at 60 °C fully loaded.
- Washing performance will not be indicated anymore, but there will be a minimum performance requirement of "A" for washing machines with a capacity more than 3 kg (see below).

EU energy label for driers

The EU energy label for driers indicates the energy efficiency, ranging from class A to G, and has not changed since its introduction in 1995 (Commission Directive 95/13/EC). Discussions are ongoing regarding revisions to the current EU energy label (see below).

ECO-DESIGN REQUIREMENTS

Introduction of eco-design requirements for washing machines

A preparatory study, "Lot 14: Domestic Washing Machines and Dishwashers" (ISIS 2007) was carried out to analyse the technical, environmental and economic aspects of these appliances. Based on this study, an Eco-design regulation for washing machines was developed and entered into force in December 2010. It sets minimum performance and information requirements for washing machines sold on the European market (Commission Regulation (EU) No 1015/2010, Corrigendum to Commission Regulation (EU) No 1015/2010).

The new Eco-design requirements can be summarised as:

- Minimum energy performance will be set to A by the end of 2011 for all washing machines and strengthened to A+ by the end of 2013 for washing machines with a capacity ≥ 4 kg. It means that washing machines below energy class A according to the new EU energy label will be banned from the market by the end of 2011.
- Minimum washing performance for washing machines with a capacity > 3 kg corresponds to A according to the current EU energy label.
- Limits are set for water consumption. They will be slightly strengthened by the end of 2013.
- Cold wash option (max. 20 °C) must be available for all washing machines by the end of 2013.
- By June 2012 instruction manuals will include detailed information on energy and water consumption, remaining moisture content, programme duration and recommendations on detergents.

No eco-design requirements for driers yet

For driers, a similar Eco-design preparatory study "Lot 16: Eco-design of Laundry dryers" (PricewaterhouseCoopers 2009) was completed in March 2009. A proposal for a draft regulation was made to the Consultation Forum in June 2010, which found that:

- The adoption of an Eco-design implementing measure is not considered at this stage and should be postponed, on the ground that the conditions set out in Directive 2009/125/EC are not met (a product shall be covered by Eco-design requirements if it presents "significant potential for improvement in terms of its environmental impact without entailing excessive costs" (Article 15(2) (c)) and the level of energy efficiency requirements "must be set aiming at the life cycle cost minimum to end-users for representative product models" (fifth paragraph of point 1 of Annex II)).
- Revisions of the current EU energy label are proposed as follows:
  - Introduction of A+, A++ and A+++ classes.
  - Inclusion of gas fired driers.
  - Inclusion of gas fired and electric (condensing and vented) driers under one common energy classification, to allow easy comparison for end-users.
  - Indication of programme duration and condensation efficiency for condensing driers.
  - A revised calculation method for the Energy Efficiency Index was proposed, aligned with the new methodology used for the washing machines new EU energy label (see above) and taking into account the capacity of the drier when determining the efficiency class (Directorate General for Energy 2010). Labelling classes would relate to yearly energy consumption according to mixed loads and no longer to kWh/kg.

Key parameters for washing machine efficiency

The most significant environmental impacts of washing machines are due to energy and water consumption during the active laundering phase (Commission Regulation (EU) No 1015/2010).

Energy consumption can be lowered by an effective load sensor, but also by the offer of a cold wash programme or by hot water supply. How well the washing machine is able to extract water from clean clothes during the spin cycle determines how much energy the drier needs to remove the remaining moisture.

An effective load sensor also reduces water consumption. However, water conservation must be balanced with the need to remove detergent in order to avoid problems for people who are sensitive to detergents. A standard covering the measurement of rinsing performance is in development. The common user practice of adding too much detergent can be prevented by automatic dosage systems. Correct dosage of detergents raises the rinsing quality and reduces the amount of chemicals released to the environment. The use of rainwater in washing machines can be an expedient and cost effective option. Depending on local water and sewage water tariffs and/or the water consumption of the washing machines, the water costs for washing machines may be as much as 50–100 % of the respective electricity costs (for further details on key parameters see Josephy 2011).

In the following sections, the following key efficiency parameters are discussed: energy efficiency, effective load sensors, spin-drying efficiency, cold wash programme availability and hot water supply.

Energy efficiency

The new EU energy label accounts for energy efficiency gains from effective load sensors, which reduce washing machine energy consumption at partial load, as well as by an optimised 40 °C programme. Power consumption in off-mode and left-on mode (standby) are of minor relevance. The increase of energy efficiency is often connected to longer programme duration.

The energy efficiency of washing machines can be further optimised. However, compared to other white goods such as refrigerators and freezers the potential is relatively limited in the near future. Additional energy saving potential lies in a high spin-drying efficiency, a cold wash programme availability and hot water supply.

Effective load sensors

The trend towards larger washing machines (6–10 kg) leads to the related problem of washing machines increasingly being run at partial load (on average between 3.7 and 4 kg per cycle, according to private communication from several manufacturers). It is important that washing machines have a sensor capable of estimating the size of the load of laundry and able to automatically adjust programme duration, energy and water consumption.

Spin-drying efficiency

As shown in Figure 1, moving from a washing machine with a spin-drying class B to one with a spin-drying class A saves three times more energy than moving from a washing machine of energy efficiency class A to class A+ (see Figure 1)[1]. In other words: the last letter of the current triple letter-EU energy label for washing machines (relating to spin speed) is of high importance to the overall efficiency of the total laundering process, in particular when an electric drier is also used.

Cold wash programme

The lion's share of washing machine electricity consumption is for heating water from the mains temperature up to 30 °, 40 °, 60 ° or even 90 °C. Washing at lower water temperatures (max. 20 °C) requires up to 70 % less electric energy.

The Eco-design regulation accounts for this high energy saving potential and requires that all washing machines offer a 20 °C-cycle after December 2013. This programme should

1. 0.02 kWh/kg are saved by increasing the energy efficiency from A to (unofficial) A+ (Washing machine with energy efficiency class A = 0.19 kWh/kg, A+ = 0.17 kWh/kg, according to the current EU energy label)

0.06 kWh/kg are saved by increasing the spin-drying efficiency from B to A (Washing machine with spin-drying efficiency class B = 52 % initial moisture content, A = 44 % initial moisture content; a drier with class B (a type that is still widespread in European households (Attali 2009)) consumes 0.51 kWh/kg if the washing machines' spin-drying efficiency is B and 0.45 kWh/kg if the washing machines' spin-drying efficiency is A).

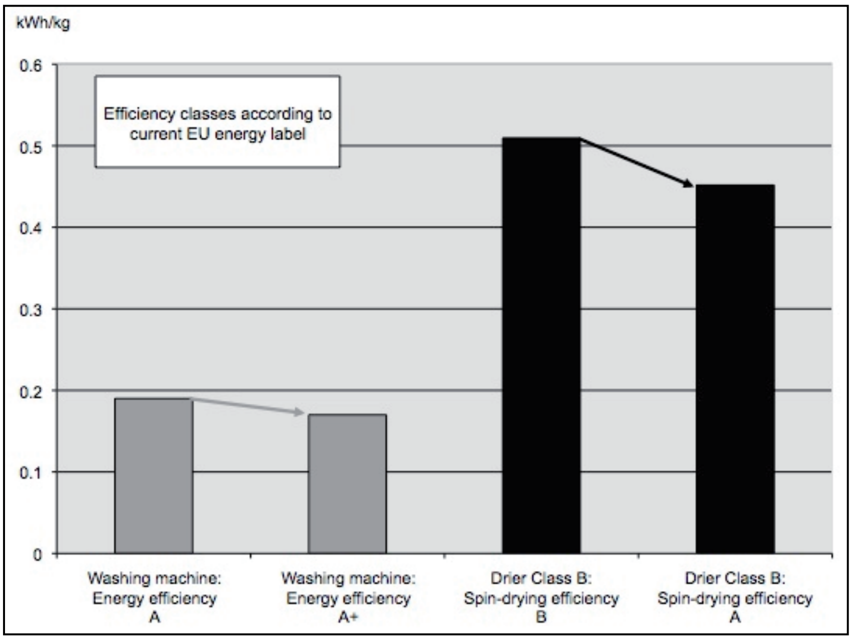


Figure 1. Energy consumption and savings per kg of laundry according to higher efficiency classes for washing and spinning (with drier class B), related to the current EU energy label, calculated by Topten.

be for cotton and easy-care and not just for wool or silk (such "gentle care" programmes are already often available).

In 2009, the Swiss retailer Migros was one of the first to develop and sell environmentally friendly detergents formulated for low water temperatures. Environmentally friendly cold wash detergents then became a standard for producers within a very short time and are recognised as an innovation by the whole laundry industry sector[2].

Hot water supply

Hot water supply for washing machines can be both economically and ecologically reasonable provided that the hot water is heated efficiently (e.g. by renewable energy sources, heat-pump-heating or district heating (e.g. from renewable energy sources or waste heat)) and that it is possible to appropriately install a warm water pipe (Bush 2005; Nipkow 2007). The higher the washing temperature, the higher the potential savings from hot water supply (up to 70 % less electricity consumption by the washing machine).

The technology is available on the European market, however, its practical use strongly differs within the European countries. It is well established in the U.S. and Canada where most washing machines do not include their own heaters and are usually supplied with both hot and cold water.

Key parameters of driers

The best potential for reducing the energy required for driers lies in further reducing the moisture content of laundry coming out of the washing machine, and in using energy efficient new drier technology.

2. For further information on detergents see e.g. wfk detergency conference and articles in Chemical & Engineering News covering enzymes, phosphates, and other aspects.

Heat pump driers are the most efficient

Compared to other household appliances, driers are energy intensive appliances. The most efficient driers on the European market integrate a heat pump. Heat pump driers only use half of the energy of conventional driers (see below, Nipkow 2009).

High spin-drying efficiency of washing machines

As shown in Figure 1, increasing the spin-drying efficiency of washing machines can have a significant impact. The more thoroughly the laundry has been spun in the washing machine, and the lower the remaining moisture content, the less energy is needed by the drier. This is due to the fact that powering a motor to spin the washer drum and remove water mechanically uses about 100 times less energy than powering a heating element to evaporate the water by thermal drying.

Changing washing machines in Europe

STOCK AND MARKET DEVELOPMENT

2005, 167 million washing machines were installed in the EU-25 (ISIS 2007). The market is mature and saturated with most new unit sales for replacement. In 2007, washing machines accounted for 6 % of the residential electricity consumption of the European Union (EU-27, Bertoldi 2009).

The current EU energy label for washing machines contains various performance parameters: energy and water consumption, washing performance and spin-drying performance. Since 2004, almost all new washing machines sold in Europe achieved energy class A according to the current EU energy label (< 0.19 kWh/kg). More and more washing machines reach an energy consumption of 0.17 kWh/kg or less, corresponding to the A+ level. However, the current EU energy label does not provide for this class and the unofficial A+ class is the result of a voluntary agreement between CECED manufacturers. The relative market share of A and A+-machines varies strongly between European countries. In 2008 the most common spin-drying efficiency classes were B and C according to the current EU energy label. As with energy efficiency, the relative market share of the spin-drying efficiency classes also varies between the European countries[3] (Attali 2009). The current standard size of European washing machines is 5 kg, however there is a clear trend towards machines with a capacity of 6 kg and larger[4].

BEST WASHING MACHINES OF EUROPE ACCORDING TO THE NEW EU ENERGY LABEL

Up to now, the testing protocols for washing machines have been based on a 60 °C standard cotton programme at full load. With the introduction of the new EU energy label programmes with lower temperatures and partial loads become relevant. Therefore washing machine energy performance under the new EU energy label cannot be compared to performance under the current EU energy label and there will be a new picture of the washing machine market.

Topten – an independent international programme designed to set a dynamic benchmark for the most energy efficient consumer products – conducted an inquiry with manufacturers on washing machines at the end of 2010, at the same time as the regulation for the new EU energy label entered into force.

The objective of the inquiry was to allow Topten to present on www.topten.eu a list of the most energy efficient washing machines available on the European market (according to the new EU energy label), similar to Topten lists for other household appliances, office equipment, consumer electronics, building components, lamps and cars.

In order to be able to sell their products on the European market, manufacturers have to test their washing machines for compliance with the new EU energy label. Going beyond merely asking for the future energy class, Topten asked manufacturers (who know Topten and are used to working with the Topten team) to provide the key parameters of their most efficient models, such as energy consumption at various temperatures and loads, including off-mode and left-on mode and the availability of other features (cold wash programme, hot/rainwater supply, etc.). One of the goals of Topten is to understand the influence of the various parameters on the resulting energy class.

At the closing date of this paper, manufacturers have not yet delivered their new product performance data based on the new testing standard. Due to the transition period between the current and the new EU energy labels, manufacturers still have time to complete their product tests. Nevertheless, the new washing machine models for the spring season 2011 will enter the market in the next weeks. We are optimistic that the list of best performing models on www.topten.eu can be prepared in time for the eceee-conference and that first results and experiences can be presented.

3. Based on GfK-sales data for 8 representative EU-countries: Denmark, France, Germany, Italy, Netherlands, Poland, Portugal, United Kingdom and from Swiss Association of the Domestic Electrical Appliances Industry FEA for Switzerland

4. One explanation could be – since the washing load does not seem to evolve – that large capacity machines are better rated on the current EU energy label.

CONCLUSIONS WASHING MACHINES

With the optimal combination of measures the electricity consumption needed for clothes cleaning can be significantly reduced, specifically by high spin-drying efficiency of the washing machine (to decrease the energy consumption for drying), by including an effective load sensor, by offering a cold wash programme, or by using hot water supply. Topten will provide the information on www.topten.eu which best-performing washing machines on the European market approach these efficiency potentials.

Changing driers in Europe

MARKET DEVELOPMENT

The market penetration of driers differs strongly between European countries, in particular between Northern and Southern and between Western and Eastern regions. Condensing driers have the largest market share (60 % in 2007 (PricewaterhouseCoopers 2009)), the relative share of vented driers sales is decreasing.

In 2005, more than 90 % of driers sold in Europe were energy efficiency class C (PricewaterhouseCoopers 2009). In 2008, most of the condensing driers sold in Denmark, France, Germany, Italy, Netherlands, Poland, Portugal and the United Kingdom were energy efficiency class B and C: 48 % and 45 % respectively (Attali 2009).

In Europe, A-class driers entered the market first in 2000. Their market share has since increased continuously, most strongly in Switzerland, Italy and Germany.

STOCK DEVELOPMENT

In 2010, the stock of driers in Europe was estimated at 62 million units. By 2020 the stock is projected to increase by 20 % to nearly 75 million units (PricewaterhouseCoopers 2009).

BEST DRIERS OF EUROPE

The most efficient driers on the European market integrate a heat pump. They are the only driers that reach class A according to the EU energy label for condensing driers.

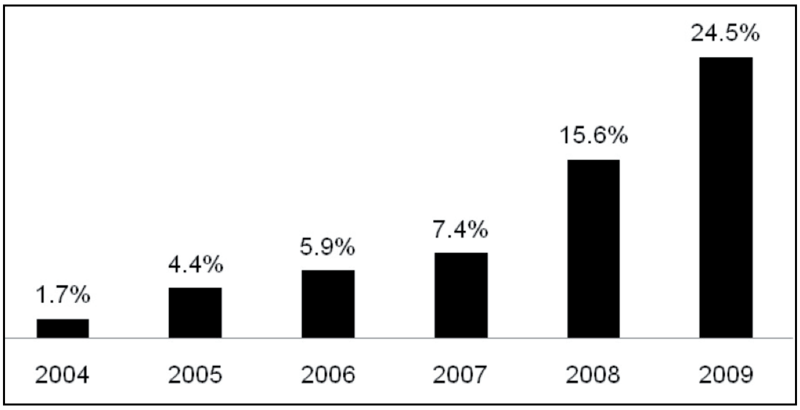
The currently most efficient heat pump driers only use 0.23 kWh per kg laundry (at 60 % initial moisture content). This significantly exceeds the threshold for the class A label (≤ 0.48 kWh/kg laundry, 60 % initial moisture). The current EU energy label implies that a class B drier is only slightly less efficient than a class A drier, while there is actually a 50 % efficiency gap between the average class A heat pump drier and class B condensing model.

The performance of the most efficient driers sold in Switzerland has increased over the years from 0.26 kWh/kg laundry in 2006 (Bush 2006) to 0.23 kWh/kg laundry in 2011 (Werle 2011). The average efficiency of the heat pump models listed on Topten was 0.38 kWh/kg laundry in 2007 and 0.28 kWh/kg laundry in 2011 (all values at 60 % initial moisture).

An overview of the most efficient driers in Europe prepared by Topten is presented on www.topten.eu ("Best Products of Europe").

compare										
Brand	V-ZUG	GEHRIG	SIBIR	Miele	FUST	V-ZUG	Bauknecht	SIBIR	GEHRIG	Blomberg
Model	Adora TL WP	WT-TL WP 958	WT-TL WP 958 Swiss	T 86-27 WP / T 86-26 WP	ADORA 599TW	Adora TSL WP	TRW 6060	WT TSL WP Swiss	WT-TSL WP 959	TKF-1350 A
List price €	2313	2313	2313	2434	1995	2625	2625	2562	2562	1744
Electricity costs (€ 15 years)	585	585	585	675	720	720	720	720	720	742
Capacity (kg)	6	6	6	6	6	6	6	6	6	6
Drying time (min)	120	120	120	104	90	90	90	90	90	120
Energy class	A	A	A	A	A	A	A	A	A	A
Energy Consumption (kWh/kg laundry)	0.26	0.26	0.26	0.30	0.32	0.32	0.32	0.32	0.32	0.33
Countries available	AT BE CH DE FR LU NL UK	CH	CH	NO, HR, EU without CY,MT,LT,LV,EE, UK	CH	BE CH DE FR IE LU NL UK	CH	CH	CH	CH CZ DE

Figure 2. Topten presents the most efficient driers on the European market on www.topten.eu (here: driers for residential use 6 kg. Energy consumption as declared at 60% initial moisture. 07.03.2011.)



(Source: Swiss Association of the Domestic Electrical Appliances Industry FEA)

Figure 3. Market share of heat pump driers sold in Switzerland 2004-2009.

MARKET INTRODUCTION OF HEAT PUMP DRIERS IN EUROPE

Switzerland – after 2012 only A-class (heat pump) driers will be allowed for sale on the Swiss market

The very first heat pump driers were introduced on the Swiss market in 2000. Since then, Topten and the Swiss Agency for Efficient Energy Use (S.A.F.E.) have been the leading force in pushing the market introduction of heat pump driers (Brunner 2010) through the:

- Measurement and testing of heat pump driers
- Development of selection criteria for highly efficient driers
- Recommendations for users about product selection and optimal product use
- Promotion of the most efficient driers on the Swiss market on www.topten.ch
- Launch of procurement and rebate programmes for heat pump driers:
  - Since 2003 procurement programmes for the housing projects of the city of Zurich
  - Since 2006 rebate programme by the Zurich Municipal Electric Utility (ewz Elektrizitätswerk der Stadt Zürich); consumers get a rebate of up to 200 Euro when purchasing an A class drier (ewz 2011)
  - Since 2007 rebate programme by several other Swiss power utilities and Swiss communities

In 2009 heat pump driers in Switzerland reached a breakthrough with a market share of nearly 25 % (see Figure 3). According to experts, market share for 2010 is estimated at over 30 %. Following this market breakthrough, Switzerland decided to ban driers below energy class A from 2012 onwards. Swiss ecological and consumer organisations advocated for this change, which was also supported by the Swiss Agency for Efficient Energy Use (S.A.F.E.) and Topten.

Europe – Breakthrough of heat pump driers is expected soon

Market share of heat pump driers is highest in Switzerland (see above), Italy and Germany. According to latest estimates, market share in Italy in 2010 rose to over 30% and in Germany to over 20 % (2008: 11 % in Italy and nearly 6 % in Germany (Attali 2009). In other European countries market share of heat pump driers is also increasing.

ECONOMICS OF EFFICIENT AND INEFFICIENT DRIERS

This section gives a brief overview about available product range, prices and cost-effectiveness of heat pump driers listed on www.topten.ch between 2007 and early 2011 (see also Werle 2011). As all products listed on Topten, heat pump driers were compared to inefficient models. The baseline for comparison (inefficient model) was a C class condenser drier, as declared by the manufacturer.

From 2000 through 2008, there were only a few heat pump driers listed on Topten, due to the limited number of products available on the Swiss market. Then, starting in 2009, the number of different heat pump drier models rose to greater than 10. The number then grew rapidly to 33 models by January 2011. (In 2010 Topten separated 6 kg load and 7 kg rated capacity driers into two lists.)

The average purchase price of heat pump driers has remained fairly constant over time, at around 1,200 Euro. However, the range of prices for heat pump driers has become wider with the increase of supply. A trend towards lower purchase prices with a number of competing brands and models has been observed. For example, AEG introduced several models in a row, priced around 1,300 Euro in 2005 and around 1,000 Euro by early 2011. Still, the cheapest heat pump driers were priced at about twice as much as the inefficient models.

The estimated lifecycle costs[5] of low- to average-priced heat pump driers have been lower than for inefficient drier models. For the period assessed, average-priced heat pump models had a life cycle cost of around 1,900 Euro, with the inefficient models' around 2,100 Euro. Life-cycle-costing may be convincing, but only if consumers are made aware of the financial (and technological) benefits of the heat pump drier.

POLICY RECOMMENDATIONS FOR DRIERS

Observing the Eco-design developments and the Swiss pioneer situation, Topten proposes the following policy measures for a successful market transformation of heat pump driers in Europe:

- Introduce Minimum Energy Performance Standards MEPS to set the right signal and push the market – both from the demand and the supply side – towards more efficient products:
  - Tier 1: the least efficient models could be banned from the market.
  - Tier 2: the performance of heat pump driers could be set as minimum requirement with sufficient lead time for the market to prepare. Implementation could be coupled to predefined sales targets of efficient driers.
- Rescaling the EU energy label with the current best available (heat pump) technology falling into class A. Class B would incorporate typical, heat pump driers. Models without heat pump technology would fall into class C and below. A+ would be reserved for future technological developments. A transition period could be left for the shift, to accommodate the market to the new scheme.
- Launching rebate and discount programmes can provide further incentives. The biggest barrier preventing consumers from buying a heat pump drier is the high purchase price. Consumers are not used to calculating life cycle costs. Thus, even if over its whole life cycle a heat pump drier is less expensive, consumers tend to purchase the cheapest (inefficient) models. This initial barrier can be overcome by specific subsidies. Once the market starts to move, and more products are sold, prices should fall due to competition and mass production.
- Informing consumers about the most efficient technologies and life cycle costs can help them choose appropriate products.

5. Calculated assuming 1,000 kg laundry dried per year, a life cycle of 15 years and an electricity price of 0.15 Euro/kWh.

Efforts for efficient driers in the USA and Canada

MARKET PENETRATION

Electric driers account for 7-8 % of the electricity usage in Canadian and American households that have them (Werle 2011) and there are contributions about energy consumption and efficiency (TIAX 2005; D&R International 2008; U.S. Department of Energy 2010; U.S. Environmental Protection Agency 2010).

Driers in North American homes are now approaching the same level of market penetration as washing machines. Table 1 shows that residential drier penetration was already high in both Canada (almost 90 %) and the USA (almost 80 %) in 2005. Electrically heated driers dominate in both countries, but more in Canada than in the U.S. where a significant share of driers are heated with natural gas or propane. Also, while condensing driers are the dominant technology in Europe, almost all driers in Canada and the U.S. are non-condensing, vented models. Vented driers pull ambient air from inside the home, heat the air and use it to dry clothes, and then expel the hot moist air through a duct to the outdoors.

There are about 80 million residential electric driers in use in the U.S. and Canada today. In its 2008 annual appliance industry snapshot Appliance Magazine estimated USA shipments of 6 million electric driers and 1.5 million gas driers in 2007 (Appliance Magazine 2008). The U.S. Department of Energy's recently released technical assessment document for residential driers estimates U.S. shipments at approximately 7 million for 2008, 80 % of which were electric (see Figure 4, The preliminary technical support document used shipments data, appliance stock, and the distribution of reported drier age in the IEA's Residential Energy Consumption Survey (RECS) in estimating the 16 year average life for existing residential stock. In comments industry recommended 12 years as referenced in Appliance Magazine).

REGULATIONS

Both the U.S. and Canada have minimum efficiency standards and energy efficiency test procedures in place for residential driers. Starting in 1994, the effective U.S. efficiency standard for electric driers was set at 1.37 kg (3.01 pounds) of water removed per kWh, equivalent to 0.73 kWh/kg (US National Appliance Energy Conservation Act). Starting in 1995, Canada adopted the same test procedures and efficiency requirements.

Table 1. USA (2005) and Canada (2007) drier stock.

Market Penetration		USA	Canada	Both
Total households	million	111.1	12.9	124.0
Households with electric driers	%	60.5%	82.9%	62.8%
	million	67.2	10.7	77.9
Households with gas or propane driers	%	18.3%	4.9%	16.9%
	million	20.3	0.6	20.9
Households without driers	%	21.2%	11.6%	20.2%
	million	23.6	1.5	25.1

(Source: Residential Energy Consumption Survey conducted by the U.S. Energy Information Agency http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/detailed_tables2005.html and data from the Natural Resources Canada Survey of Household Energy Use 2007 http://www.oee.rncan.gc.ca/publications/statistics/sheu07/pdf/sheu07.pdf. On average, one drier per household is assumed.)

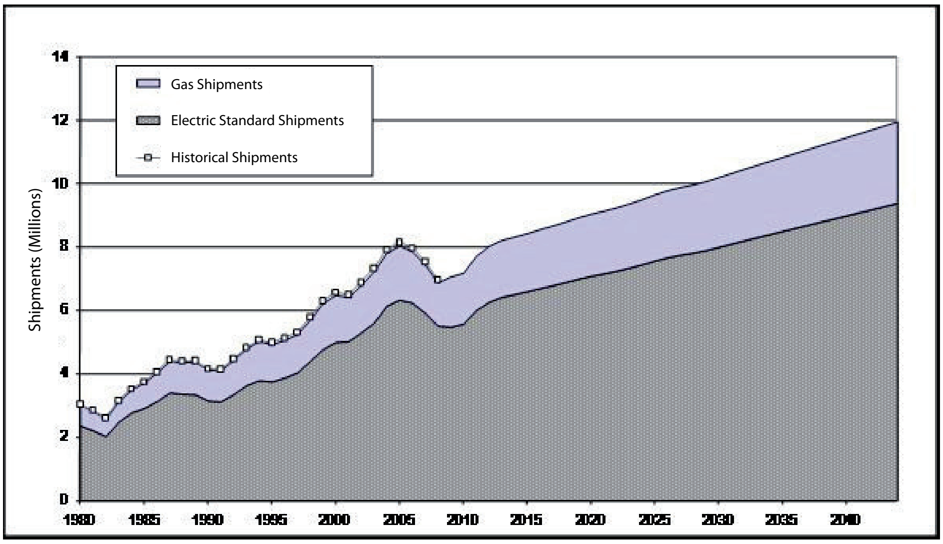


Figure 4. Historic and Projected U.S. Drier Sales. (DOE preliminary technical support document for residential driers rulemaking. The growth rate projected may be overly optimistic due to drier saturation in non-multifamily dwellings and the current surplus of housing stock in the U.S.)

The minimum requirements are still in place, unfortunately because the test procedures had not kept pace with the development of drier technology, they no longer provide accurate assessments of the energy efficiency of products on the market. In addition to the minimum efficiency standards, Canada also requires that driers carry the EnerGuide label showing relative energy efficiency. However, there is no requirement for U.S. driers to carry the similar U.S. Energy Guide label. More important for the North American market, the ENERGY STAR voluntary energy efficiency labelling programme currently covers washing machines but not driers. Therefore consumers have little information on which to make energy efficiency comparisons.

ENTERING A NEW ERA

U.S. and Canadian energy policy has not focused on driers as it has on other household appliances because it was widely believed that there was little that could be done to improve drier energy efficiency. This situation is now changing. In 2009 the U.S. Department of Energy started a process to update its drier energy efficiency test procedure, which culminated in the release of a final ruling on January 6, 2011. This new test procedure should allow a much more accurate assessment of drier energy efficiency, and can support future policy initiatives such as revised minimum efficiency standards and an ENERGY STAR label for driers. Canada has just initiated its own drier test procedure revision process. A new Canadian dryer test procedure, harmonized with the US procedure, should be in place by the second quarter of 2012.

Recent research has shown that even without new minimum efficiency standards, driers in the U.S. and Canada today use about 17 % less energy than they did in 1990. This improvement has been due to the greater use of moisture sensors to end the drying cycle when the load is dry, thus eliminating the over-drying that was common with older electro-mechanical controls. There is also a growing awareness of the European experience with heat pump driers, and interest in exploring similar opportunities in the U.S. and Canada.

In 2009, the New Jersey Clean Energy Program awarded research funds that created the Super Efficient Dryer Initiative (SEDI). During the summer of 2010 SEDI held meetings across the U.S. and Canada to develop a road map for a successful market introduction of super-efficient driers in North America. The SEDI research team is working with appliance manufactur-

Table 2: Potential Savings from Heat Pump Drier in the U.S. and Canada.

European Heat Pump Dryer Compared to:		Standard	Higher Efficiency
Annual Savings	kWh/year	462	332
	USD/year	76	54
Lifetime Savings*	kWh	6,926	4,984
	USD	1,136	817
Price Premium**	USD	405	253

*Assumes average drier lifespan of 15 years, and New Jersey average electricity price of $0.16 per kWh

**Price Premium for projected North American model heat pump drier

ers to draft voluntary technical specifications for efficient driers that could be the basis for consumer purchase incentives, and for a possible ENERGY STAR driers programme. In 2010 the U.S. government awarded funds to technology development firms and appliance manufacturers for the development of new super-efficient driers.

TEST OF EUROPEAN HEAT PUMP DRIERS TO U.S. STANDARD

One of the barriers to comparing the energy efficiency of driers in Europe and North America is differences between the relevant EU and US/Canadian test procedures. To help provide more information, during the summer of 2010, Ecos Consulting, a U.S. energy efficiency consulting firm, tested a popular heat pump drier model currently available on the European market using the U.S. Department of Energy procedure (Ecos Consulting 2010). Ecos's testing yielded savings estimates consistent with testing by the Swiss Agency for Efficient Energy Use (S.A.F.E.) beginning in 2005. The European heat pump model used 40-50 % less energy than the average conventional North American model to dry the same load of clothes. In this research Ecos did not attempt to estimate the secondary heating and air conditioning savings from eliminating drier venting.

Ecos Consulting also found another performance difference in addition to energy efficiency. The European heat pump drier cycle length was 110 to 122 minutes, compared to 23 to 59 minutes for the vented U.S. driers. In Europe, the heat pump drier competes primarily with condensing electric resistance driers, which also tend to have longer drying cycle times. Canadians and Americans are accustomed to shorter drier cycles but it is not clear if this will present a barrier to adoption of heat pump drier technology.

Table 2 shows SEDI's synthesis of Ecos Consulting's test results for the European heat pump drier and estimated laundry, heating and air conditioning savings compared to both standard and the most efficient driers currently for sale in Canada and the U.S.

Conclusions

Domestic laundry appliances continue to evolve in Europe and in North America. In both regions most homes already have washing machines. In Europe, new regulations and a new EU energy label are upcoming, to which the market and consumers need to get accustomed. Topten aims to contribute to this by publishing a list of the best performing washing machines available on the European market early in time. Europe is also seeing a strong trend towards a higher penetration of driers, and towards more efficient drier technology, specifically condensing heat pump driers. In North America most homes already use inefficient, vented driers.

The most energy-efficient driers today include heat pump technology. Heat pump driers have been proven successful in both the laboratory and the marketplace in Europe rapidly gaining significant market shares in several countries (Switzerland, Italy, Germany). Drawing from these developments, first tests of heat pump driers have been carried out in the USA. The results strongly suggest that heat pump technology could yield cost-effective savings in North America as well. Important policy initiatives are currently underway which will support a North American market for energy efficient driers.

The Swiss example demonstrates that market transformation can be achieved with a coordinated effort of the different stakeholders (policy makers, manufacturers, utilities, non-governmental organisations, and so on). Its success shall encourage similar activities in other countries.

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