How has the European White Goods market changed in the past 10 years? – Analysis based on sales data reveals constant improvements, contradictory trends, and big successes for a new technology.

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Abstract

In Europe, there is no systematic market monitoring and only little is known about product market trends. In order to decide on and evaluate policies such as MEPS and Energy Labels, knowing the market is however key.

We have analysed comprehensive sales data from GfK on refrigerators, washing machines and tumble driers, covering France, Germany and Italy as well as the whole European Union, and the years 2004 – 2015. The data contains information on energy efficiency, energy consumption, size and price. The report will be published in March 2017.

Results show different trends for the three product categories. Refrigerators show a constant efficiency improvement over these eleven years. Average energy consumption has decreased, but at a lower rate than what could be expected based on the efficiency improvements.

For washing machines, results show that 'efficient' washing machines tend to be large washing machines. With increasing efficiency also the trend to larger drums is continuing. Because partial load washing is very inefficient and will most likely occur more often in large drums, we find it difficult to judge these results.

Heat pump tumble driers, using half as much energy as conventional driers without heat pump and populating the classes A to A+++, have continued to gain popularity. In 2015 heat pump drier sales reached 47% across the EU. In some countries like Germany or Italy, they even accounted for 75% or more of the sales. Analysis of total lifetime costs shows that heat pump driers save consumers around 500 Euros over class B driers.

Introduction

The revised Energy Labelling framework Directive will most likely introduce a mandatory product registration with a database that will be partly publicly accessible. This database is needed and will greatly improve the overview on market developments for the Commission and other policy stakeholders [1]. It will provide detailed information on models that are on the market, their energy efficiency and consumption etc.

Up to now, there has been no systematic market monitoring in Europe. Whenever the European Commission needs market information about products to take decisions about future policy measures, available data is gathered by consultants for preparatory studies or impact assessments. The problem with such data, which is often provided by industry, is that it may be incomplete and often outdated, and cannot be compared over time and between countries. For designing policy instruments such as Energy Labels and minimum energy performance standards (MEPS) that are well adapted to the market and effective, it is key to have current market data and trends.

The product database will greatly improve the data situation. Apart from this it will also serve consumers and market surveillance authorities [1]. However, it will not contain any information on the importance of different models regarding sales, and it could take a long time until it's operative. Sales data is available – professional market research companies have it – and sales-based market monitoring could start now.

Thanks to funds from l'Agence française de l'Environnement et de la Maîtrise de l'Energie (ADEME), recent sales data for refrigerators, washing machines and tumble driers could be purchased and analysed. The report [2] has been published in March 2017 and is partly an update, partly an amendment to a similar study from 2015 [3]. It demonstrates the value of systematic market monitoring based on sound sales data (recent, complete, consistent over time). At the same time it provides valuable market information to the on-going Ecodesign and Energy Labelling review processes for refrigerators and washing machines, and that for tumble driers that is due to start this year.

Data

Sales data including information on energy class, energy consumption and size has been purchased from GfK[1]. GfK obtains the data from retailers. The data covers the years 2004 to 2015. All the information is based on declarations on the Energy Label, and average values are weighted according to sales. The data covers household refrigerators, washing machines and tumble driers. For refrigerators, the data covers refrigerators with and without freezer compartment, but not separate freezers. Next to the information for the entire EU, our report also covers the national markets of France, Germany and Italy.

Key results and discussion

Only the key results are shown here. More results, especially for France, Germany and Italy, can be found in the main report by ADEME [2].

Refrigerators

When the Energy Label for household refrigerators was introduced in 1994, it was the first such Label. The original A to G Label was amended with classes A+ and A++ in 2004, in 2011 A+++ was added. The Label and Ecodesign regulation are currently under revision: the preparatory study has been published in March 2016 [4].

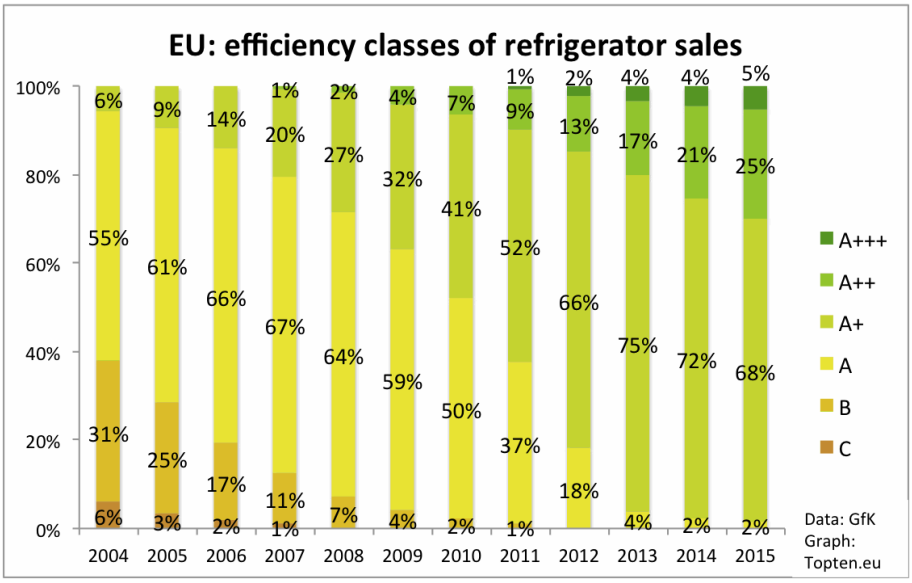

Figure 1: EU: efficiency classes of refrigerator sales

Figure 1 shows that the energy efficiency of refrigerators in the EU has constantly improved from 2004 to 2015. Over this period, the sales-weighted average energy efficiency index (EEI) has improved by 37% (average EEI in 2015: 39)[2].

[1] www.gfk.com

[2] Average EEI was calculated by assigning the threshold EEI to each class (e.g. 33 for A++).

In 2004, most of the sold refrigerators were in classes A and B. New, better classes were needed. In 2004 class A+ was introduced, and sales of A+ refrigerators quickly increased. By 2015, the majority of all refrigerators sold are in this class. Classes B and C were banned from the market in 2010, but both had nearly disappeared before this date. A stronger effect on the market was caused by the second tier of the Ecodesign regulation from 2009: the disappearing of class A was visibly sped up by the Ecodesign requirements. A++ refrigerators make up one quarter of the sales in 2015, sales of A+++ models are still low.

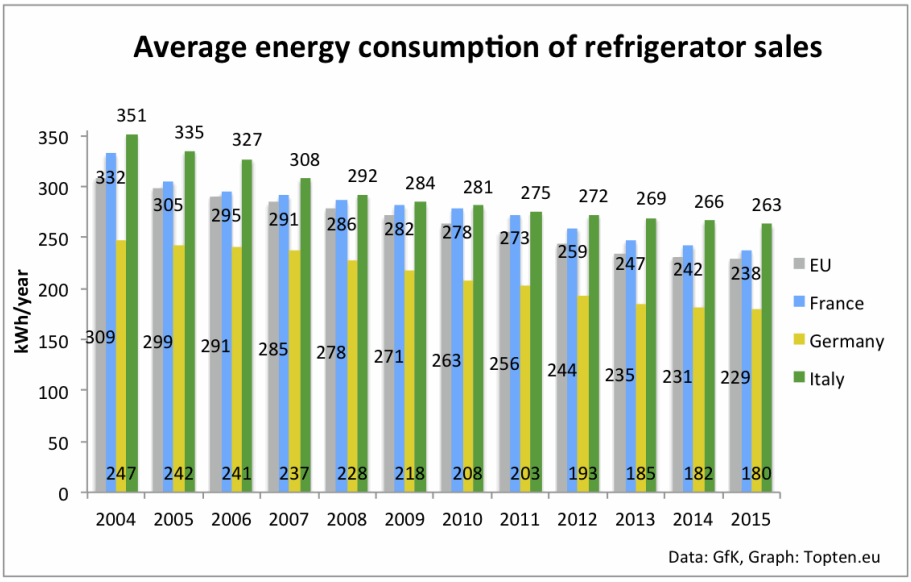

Figure 2: Average energy consumption of refrigerator sales in the EU

Refrigerators sold in the EU in 2015 on average consume 229 kWh/year. This is 26% less than eleven years earlier in 2004. Even though it is a considerable reduction, it is less than could be expected from the 37% efficiency gains that were achieved over the same period. Figure 3 shows that this deviation cannot be explained by increased average volume: in 2015, it was only 10 litres (4%) larger than in 2004. Instead, the deviation can likely be explained by the complex EEI formula, which does not establish a direct link between energy consumption and efficiency: different reference lines for different product types and correction factors for extra features (inbuilt, frost-free and tropical models, models with chill compartment). A measurement campaign that was performed in 100 French households in 2015 funded by ADEME [5], also observed that inbuilt and frost-free refrigerators are consuming more energy, even if smaller and rated as equally energy-efficient as comparable models without these functions.

French refrigerators consume on average 9 kWh/year more, Italian ones 34 kWh/year more than the EU average. The higher average consumption by refrigerators sold in Italy can likely be explained by an average energy efficiency that is below the EU average, and a preference for larger models [2]. Less energy than across the EU is consumed by refrigerators sold in Germany: these use on average 59 kWh/year less. The situation is the contrary from that in Italy: German refrigerators are on average more energy-efficient and smaller than across the EU [2].

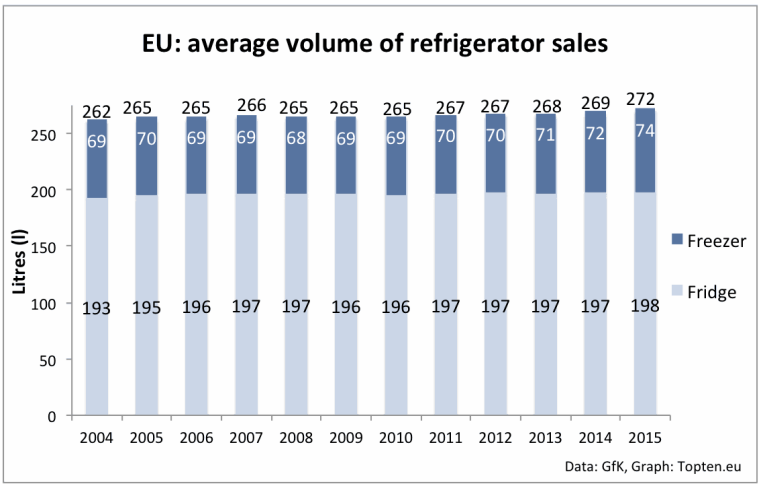

Figure 3: EU: average volume of refrigerator sales

Average total volume has increased by 10 litres (4%) over the past eleven years. The average volume of freezer compartments has increased by 5 litres (7%), while cooling compartments also increased (2%). Results in [2] show that more energy-efficient refrigerators are on average larger: A+++ refrigerators are on average larger than A++ models, and these again are larger than A+ models.

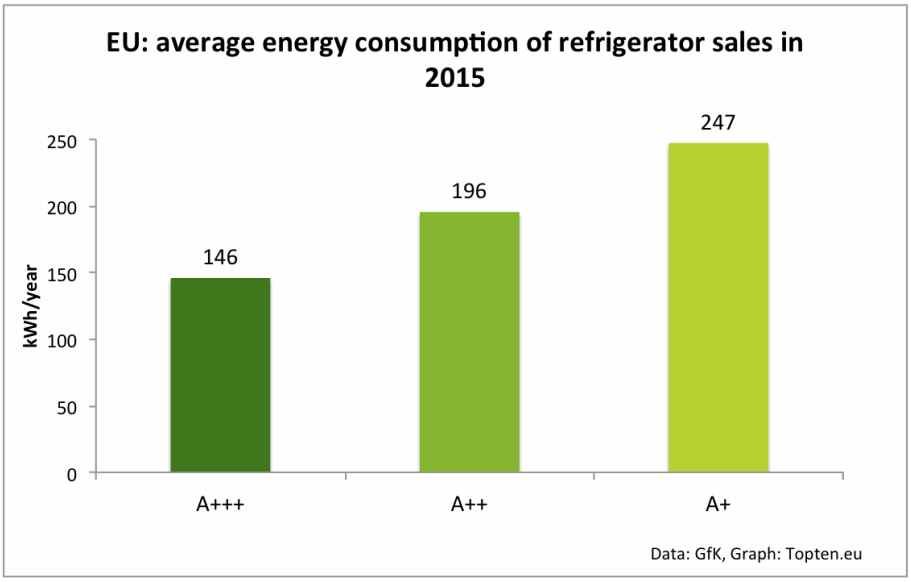

Figure 4: EU: average declared energy consumption of refrigerator sales according to label classes in 2015

Despite this size bias, more energy-efficient refrigerators save a lot of energy on average: Figure 4 shows that while A++ refrigerators save 51 kWh/year (21%) over A+ models, A+++ save 101 kWh/year (41%).

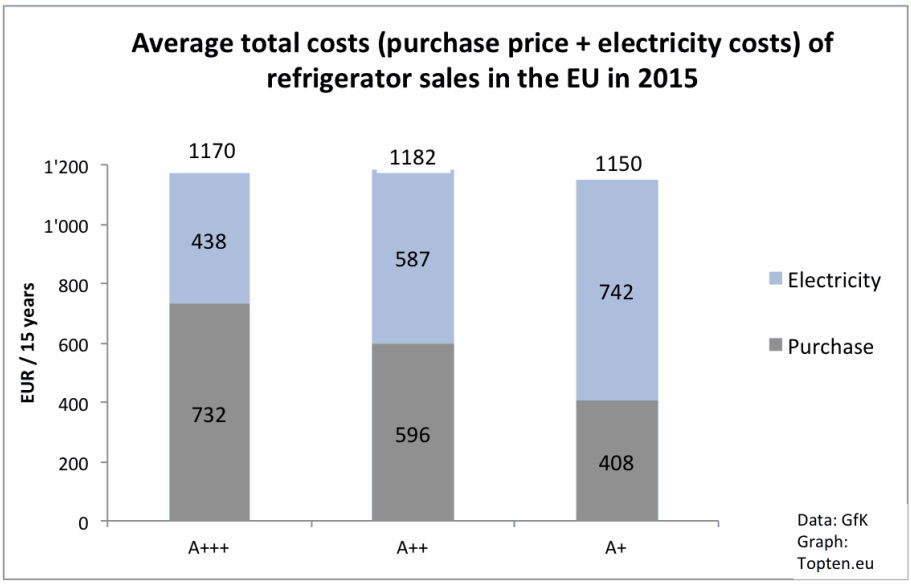

Figure 5: Total costs[3] (purchase price + electricity costs) of refrigerator classes

A+++ refrigerators save households electricity costs of over 300 Euros over their lifetime of 15 years. However, this is not (yet) enough to make up for the price premium of more energy-efficient models: yet, total costs to consumers are lowest for A+ refrigerators. However, it must be noted that the higher prices for A+++ models do not only reflect higher energy-efficiency, but also the larger average volume. And the differences in total costs are small, less than 2 Euro per year.

Washing machines

The first Energy Label for washing machines was introduced in 1995. Energy efficiency was initially as specific energy consumption of the 60°C programme per kg capacity. In 2011/2012, the Label scale was amended with classes A+, A++ and A+++. With this new labeling regulation, the classification scale is based on an energy efficiency index (EEI), which is based on annual energy consumption. The programmes relevant for the energy label are the 60°C and the 40°C cotton programmes, also including half load cycles. The annual energy consumption formula assumes 220 wash cycles per year and includes low power modes (Left-On (until its turn off) and Off mode) there are different ways to measure. This means that the declared energy consumption before and after 2011/2012 cannot be directly compared.

As for refrigerators, the Energy Label (defining label and threshold) and Ecodesign regulations (obligations, water consumption , environmental aspects, mercury, etc.) for washing machines are currently being revised. The Joint Research Centre (JRC) should publish the final preparatory study[4] soon.

[3] Total costs include purchase price and electricity costs over the product lifetime. Assumed refrigerator lifetime is 15 years, electricity price 0.2 Euros/kWh (no increase in prices over time, and discount rate assumed).

[4] http://susproc.jrc.ec.europa.eu/Washing_machines_and_washer_dryers/index.html

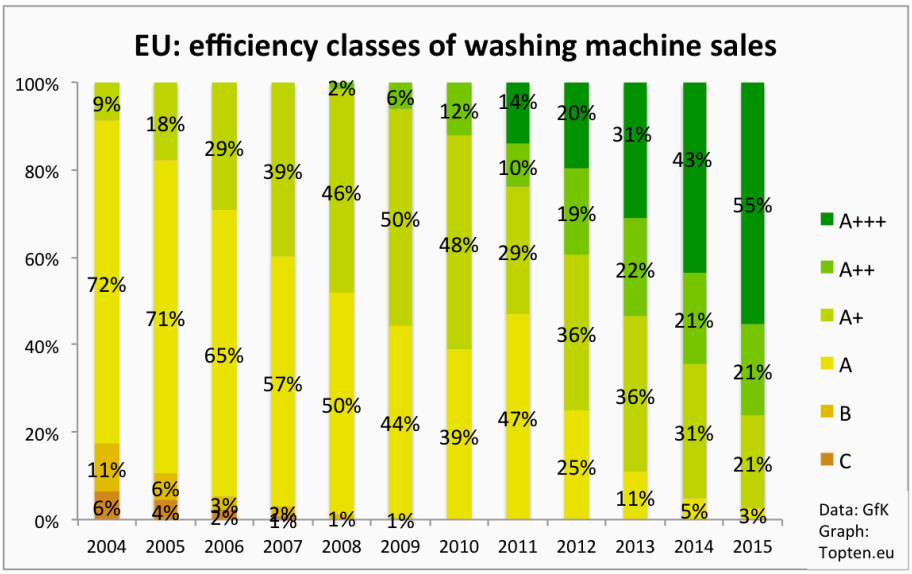

Figure 6: EU: efficiency classes of washing machine sales. Note: Classes A+, A++ and A+++ were only 'official' from 2011: before 2011, GfK categorized products as 'A-10%' (or A+), and 'A-20%' as A++. Sales share of these classes before 2011 has to be interpreted with caution.

Keeping in mind that classes A+ and A++ were only officially introduced in 2011 (see figure notes), Figure 7 shows that from 2004 to 2010, for six years nearly all washing machines sold were in class A. When the new classes were introduced in 2011, already more than half of all models sold in the EU met the requirements of classes A+, A++ or A+++. This illustrates that the revision was long overdue. Tier one of the Ecodesign regulation from 2010, which banned classes B and below from December 2011, had no effect. Tier 2 banned class A from December 2013, and had a minor effect: in this year, still 11% of the sales were in class B. In 2015, four years after the new Label classes were introduced, the majority of all sold washing machines were in the top class A+++. The most energy-efficient washing machine model exceeds the A+++ threshold by 50%[5]. Clearly, MEPS and Label classes defined in 2010 were not ambitious enough: the current revision is needed.

[5] V-Zug Adora SLQ-WP with integrated heat pump; EEI= 22.8, 8kg. Source: www.topten.eu

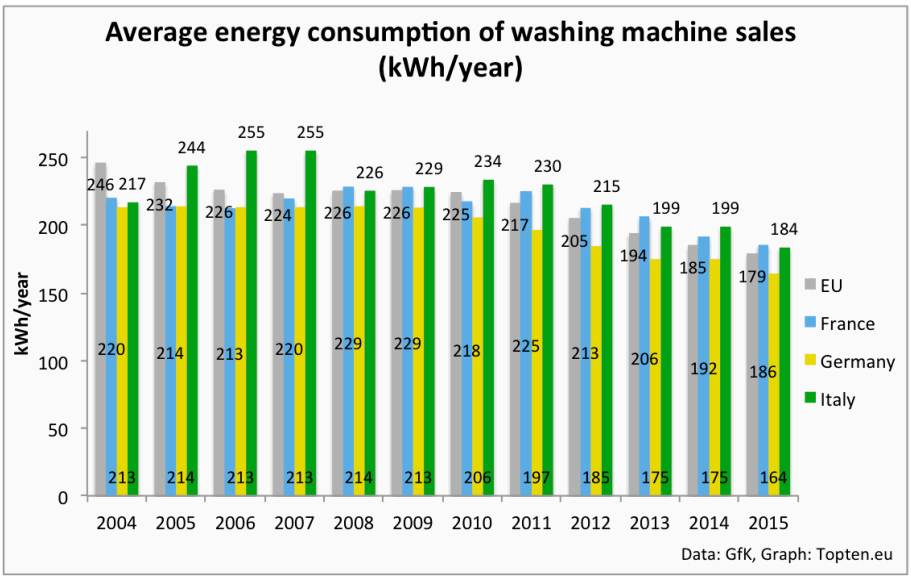

Figure 7: Average energy consumption of washing machine sales in the EU, France, Germany and Italy. Note: Before 2011/12 the energy consumption was declared in kWh/cycle. These values have been multiplied by 220 by GfK. This is the number of annual cycles assumed for the declaration on the 2010 Energy Label which applied from December 2011. Since the new declaration also includes part load, 40°C cycles and low power modes consumption, the values are not directly comparable. While the exact values have to be read with caution, this chart can show trends before 2011 and after. Decline in energy consumption can also be explained by reduced wash temperatures for the nominated programmes as there is no requirement for the actual wash temperature to match the programme name.

Before the Label revision in 2010, the annual average energy consumption of washing machines sold was more or less stable for many years. Only after the introduction of the new Label in 2011, the average declared energy consumption started to go down. In 2015, the average energy consumption of washing machines sold was 179 kWh per year. A part of the observed reduction will simply be due to the inclusion of less energy-intense programmes to the calculation (40°C instead of only 60°, half load instead of only full load cycles) and other changes. Similar as for refrigerators, also washing machines sold in France and Italy consume a bit more energy than the EU average (7 and 5 kWh/year, respectively), while those sold in Germany use 15 kWh/year less.

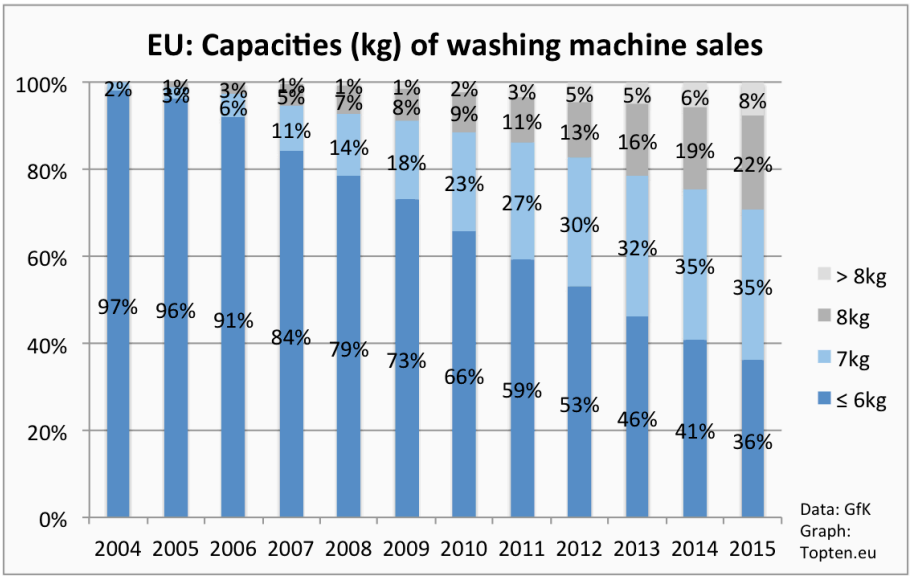

Figure 8: EU: capacities of washing machine sales

The strong trend to larger washing machines observed in the past few years is on-going (Figure 8). While in 2004 nearly all washing machines had a capacity of 6kg laundry and less, by 2015, 65% were designed for more laundry. 30% can even take up 8kg or more laundry.

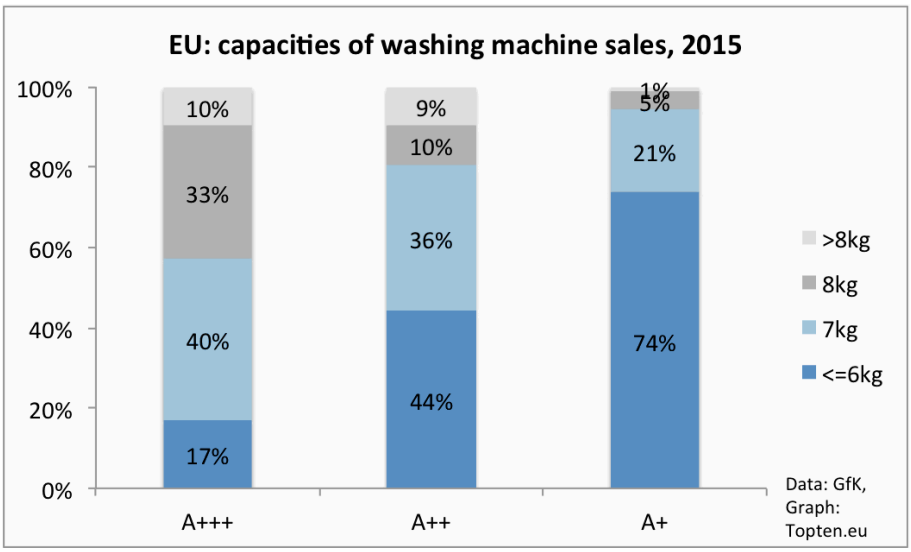

Figure 9: EU: capacities of washing machine sales according to energy classes, 2015

Figure 9 shows that there is a correlation between energy classes and drum size: energy-efficient washing machines tend to be large washing machines.

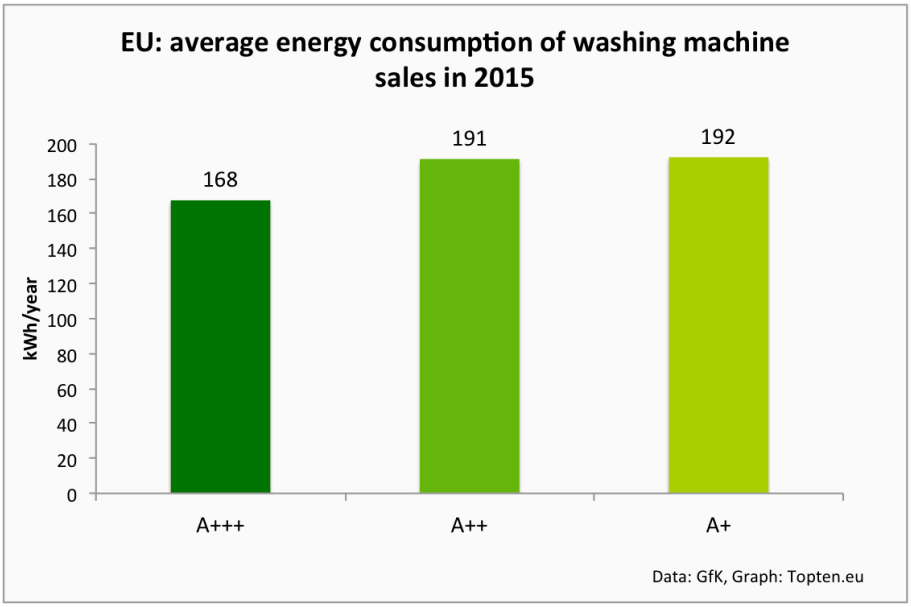

Figure 10: EU: average energy consumption of washing machine sales according to energy classes, 2015

The correlation between energy class and energy consumption on the contrary seems less clear: as Figure 10 shows, the differences in average energy consumption between energy classes are small (A++ to A+++: -23 kWh/year) to nearly inexistent (A+ to A++: -1kWh/year).

Reasons for this weak correlation between efficiency classes and energy consumption could be:

- 'Narrow' classes: less than 12% efficiency improvement is needed to jump from one class to the next. For most product categories, energy classes are larger (e.g. for refrigerators or tumble driers it is around or more than 25%).

- Washing machines in better classes are larger, as shown in Figure 9. It seems that the reference line, which is defining how much more energy larger machines can use while still meeting a good efficiency level, makes it easier for larger models to reach good efficiency levels in the case of washing machines – i.e. there is size bias in the labeling equation which favours larger machines.

A+++ machines may have a relatively low declared relative energy consumption (kWh/kg laundry), but the absolute declared consumption is hardly lower than that of 'less efficient' machines. Another aspect is part load washing: several studies have indicated that users do not wash larger loads in larger machines [6], and that the average load is below 4 kg [7]. Clearly, the risk of a (low) part load cycles is bigger for larger washing machines. If filled only partly, large washing machines will be clearly less efficient: water and energy will be wasted.

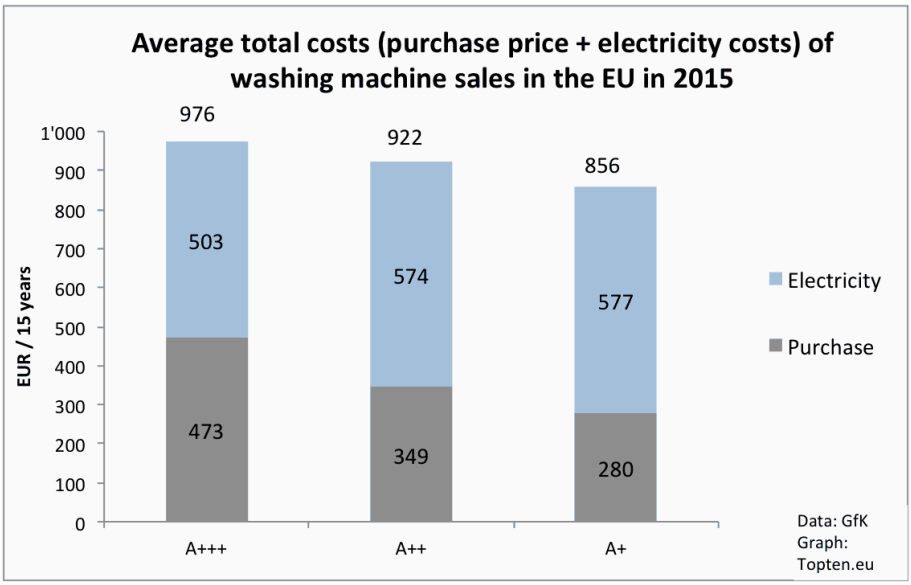

Figure 11: EU: Total costs[6] (purchase price + electricity costs) of washing machine sales in 2015

Washing machines in better efficiency classes have clearly higher purchase prices – not only because of more efficient technology, but also because they are larger. The energy consumption however is nearly the same across efficiency classes – therefore consumers cannot save on total costs with more efficient washing machines.

This situation means that, based on the current EEI formula, it is not possible to introduce more ambitious MEPS: first, because these would ban small, potentially low-consuming models. Second, because MEPS must be set at the Least Life Cycle Cost (LLCC) point. With mostly large machines in the better efficiency classes, the LLCC is at low efficiency.

Tumble driers

The first energy label for tumble driers was introduced in 1996. As for washing machines, the energy efficiency definition followed a relative energy consumption per kg laundry definition. Class A could only be met by heat pump driers, which entered the market in 2006. Heat pump driers exceeded the class A threshold by around 30% and used almost 50% less energy than class B driers, which entered the market at the same time: the Energy Label could not visualise the vast efficiency gains of this technology. In 2012, the Energy Label was revised, and Ecodesign requirements were

[6] Total costs include purchase price and electricity costs over the product lifetime. Assumed washing machine lifetime is 15 years, electricity price 0.2 Euros/kWh.

announced. The Label was amended with classes A+ to A+++, which can all only be reached by heat pump driers to date. Like for washing machines, the labeling scale is now based on an EEI that is calculated by annual energy consumption and capacity. The formula assumes 160 drying cycles per year, some of them at half load, and low power modes. The Labelling and Ecodesign regulations are due for review in 2017.

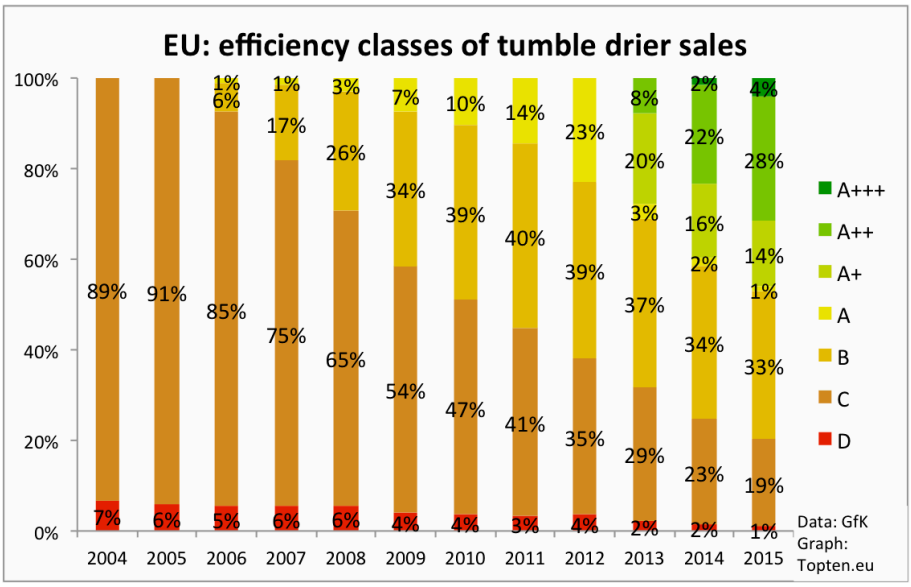

Figure 12: EU: efficiency classes of tumble drier sales

Figure 12 shows that class B gained market share much faster than class A, while both of them slowly replaced class C. Only after 2013, when the new Label was introduced to better communicate the superiority of heat pump driers, the sales share of this technology increased faster. Class A has been virtually empty since then – it is situated at the 'technology gap' between conventional driers and those with a heat pump. Tier one of the Ecodesign MEPS banned driers of class D and below from November 2013. As for refrigerators and washing machines, this first tier measure had nearly no impact on the market. Tier two has banned driers of class C from November 2015. With 20% class C driers still being sold in 2015 across the EU, this measure will certainly have a bigger effect.

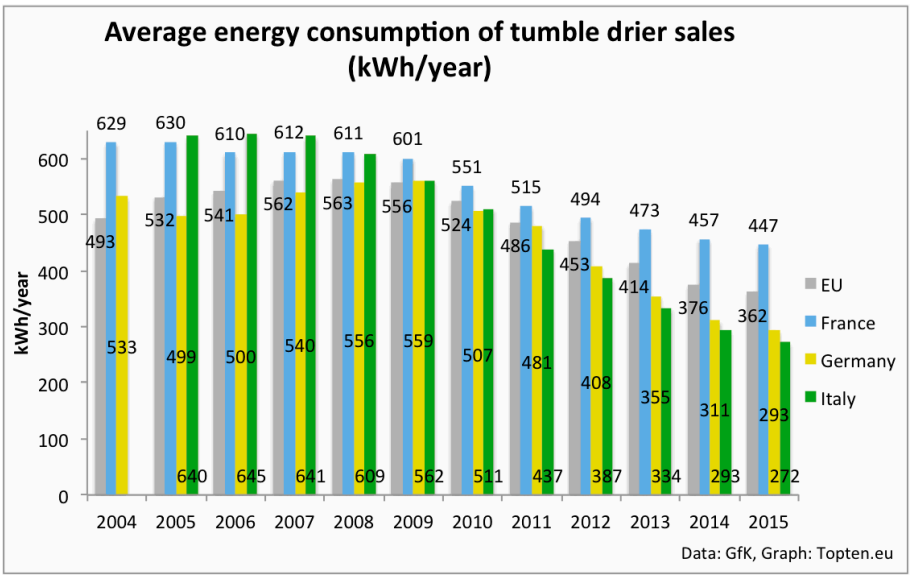

Figure 13: Average energy consumption of tumble drier sales in the EU, France, Germany and Italy. Note: Declared energy consumption according to the old Label (2004 – 2012, in kWh/cycle) has been multiplied by 160 (cycles/year). It is however not directly comparable with the declaration on the new Label, because this includes part load drying and low power modes consumption.

In 2015 the average energy consumption of tumble driers sold in the EU was 362 kWh/year. This is 27% less than in 2004, and 36% less than in 2008, when average energy consumption of driers was highest. Differences between countries are large and reflecting different efficiency levels of national markets shown in [2].

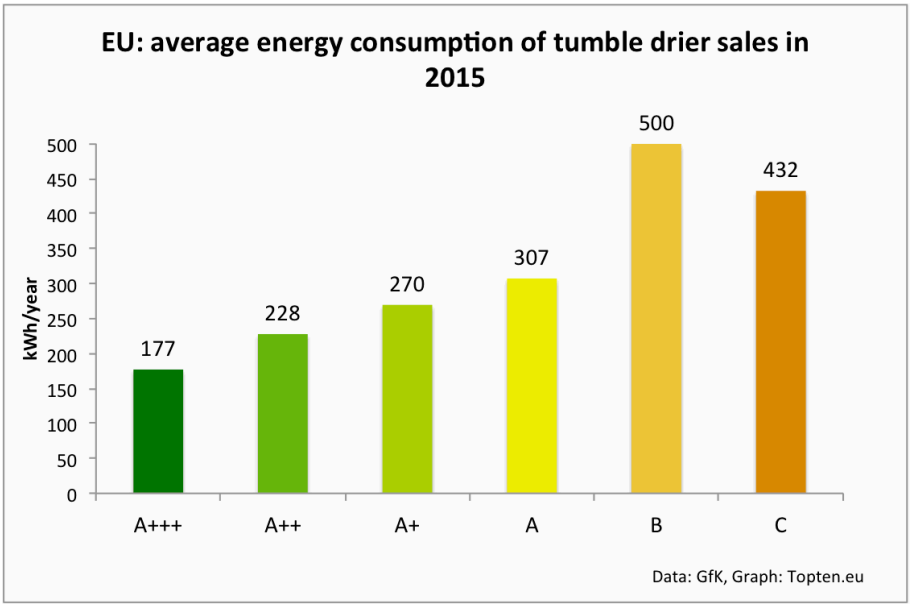

Figure 14: EU: average energy consumption of tumble drier sales, 2015. A class has a very low sales share and nearly no models exist in this class, therefore this result is not statistically significant.

Class A+ heat pump tumble driers on average consume 230 kWh/year (46%) less energy than class B driers, the least efficient still allowed on the EU markets. Also, the differences between heat pump driers are considerable: class A++ driers save 42 kWh/year (15%) over A+, A+++ saves 93 kWh/year (34%). These differences between classes are clearly larger than for washing machines. Surprisingly, class B driers consume on average more energy than class C models, which have been banned since 2015. The reasons may be similar to washing machines: a small efficiency improvement needed to go from class C to B (only 10.5%), combined with an increase in average capacity shown in [2]. For other classes, the efficiency improvement required is bigger: 25% from A++ to A+++, and 35% from A to A+. The high average consumption of class B driers raises concerns over the energy-saving effect of tier 2, having banned class C driers since last November. **If consumer choose class B driers instead of C, the measure could even increase energy consumption. This could be avoided if heat pump driers are promoted. T**his should be easy: they save money for consumers (Figure 15). This chart shows that paying a higher purchase price for more energy-efficient driers is paying off. A+ driers can save 473 Euros over their lifetime of 15 years compared to class B conventional driers, A+++ save as much as 580 Euros – despite their higher purchase prices, and thanks to their low energy consumption.

Ecodesign MEPS should be set at the LLCC point. For tumble driers, this means that in the review that is about to start this year, driers without heat pump should be banned from the market. Switzerland has banned non-heat pump driers since 2012.

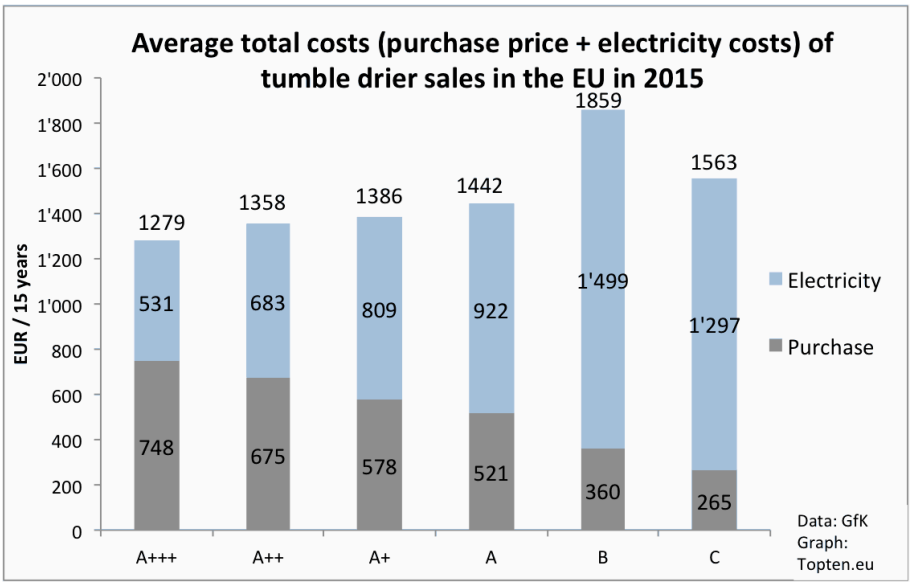

Figure 15: EU: average total costs[7] (purchase price and electricity costs) of 2015 tumble drier sales. A class has a very low sales share and nearly no models exist in this class, therefore this result is not statistically significant.

Conclusions and recommendations

For **refrigerators**, the Energy Label has successfully supported continuous innovation towards higher energy efficiency. Ecodesign requirements may have supported this development, but the major driver has been the Energy Label. Despite more than 20 years of efficiency improvements, energy-efficient refrigerators still represent a large energy saving potential. Improving the 2015 average efficiency (EEI = 39) to the A++ level (EEI = 33) would save 15% energy. If all refrigerators sold in 2015 had been in class A++, Europe could have saved 7.9 TWh over the lifetime of these models.

Introducing new MEPS at the level of A++ is recommended. Since national markets are not all equally efficient, these should be announced some time before actually being implemented. A new Energy Label should be introduced, following the A to G scale with initially empty top class(es) as foreseen in the future revised Label framework regulation. Today, only 'plus'-classes are left on the market, and best available technology (BAT) products are exceeding the A+++ threshold by 20%[8]. In the ongoing revision, also the EEI formula should be simplified, and misleading factors should be removed. Results show that there is a gap of 30% between efficiency improvements and reduced energy consumption over the past eleven years. These are lost savings with the only explanation for most of this due to the lack of transparency in the current EEI formula. Popular combi refrigerator-freezers can consume much more energy than other types and still meet good efficiency levels thanks to their steep reference line. Models with energy-consuming features such as frost-free, compressors that work under tropical conditions, chill compartments or inbuilt models can also consume more, without this extra energy consumption being made transparent, thanks to the 'correction factors' in the formula. The EEI formula is incentivising these features instead of making their higher consumption transparent. These correction factors should be removed, no new ones should be added, and the number of different reference lines should be reduced to one or two (similar to what has been proposed in the preparatory study [4]). Comparable product types should be rated on the same basis using their measured energy and volume so that more efficient configurations are rewarded with higher label ratings. Currently, separately rating inefficient configurations allows them to achieve higher classes with higher energy consumption. The labeling classes should be restructured so that

[7] Total costs include purchase price and electricity costs over the product lifetime. Assumed drier lifetime is 15 years, electricity price 0.2 Euros/kWh.

[8] Source: www.topten.eu

the energy reductions per additional class are more consistent: this would also have more meaning for consumers.

For **washing machines**, the effect of the Energy Label is not so clear. Since the new classes A+ to A+++ have been added in 2010 there has been a clear shift to improved energy-efficiency. The declared energy consumption also seems to have declined since then. However, with more than 50% of all sold models in class A+++, the Label is already outdated, only four years after its introduction. BAT models are 50% more efficient than the A+++ threshold[8]. Class threshold have not been designed ambitiously enough. Also it is not clear to what extent observed reductions in energy consumption are 'real' or due to changes in calculations and measurement methods. The most problematic aspect with washing machines is the strong trend to larger drums, which may be supported by the Energy Label. The strictly linear reference line used makes it easier for larger machines to reach good efficiency levels. It seems that it's easier for manufacturers to reach good efficiency classes by increasing the drum size instead of reducing the energy consumption. If washing machines are not loaded to their full capacity, water and energy is wasted. The larger the drum, the bigger the risk of resource waste.

As for refrigerators, the washing machines Energy Label should be revised to follow an A to G scale. New, more ambitious MEPS thresholds should also be considered. But these are not possible based on the current EEI formula: small, potentially energy-saving models would be banned, and total costs to consumers would increase because of higher purchase costs and very little savings on electricity costs. It is key that the EEI formula is revised to remove the misleading incentive towards larger washing machines. A digressive reference line, granting less additional energy consumption per added kg capacity for a given efficiency to larger machines, should replace today's strictly linear reference line. Adding a fixed small amount of laundry to the test runs (e.g. 2kg instead of 50%) could support efficient washing of small loads and these should be more heavily weighted in the class calculation. A 2015 consumer survey showed that the Label programmes cotton 40°C and 60°C are used for less than 17% of all wash cycles [8|. In order to increase usage of these programmes, the Label programmes should be user-friendly (not lasting too long) and easy to find (no second version of Label programmes with lower efficiency).

In 2015, energy-efficient heat pump **tumble driers** (classes A and better) accounted for nearly 50% of all sales in the EU. On national markets, it can be as low as 18%, or as much as 93% [2]. Heat pump driers save at least 50% energy over conventional class B driers and save users total costs over their lifetime, despite their higher purchase costs. Across Europe, heat pump driers hold a considerable saving potential: had all driers sold in 2015 been in class A+, Europe could have saved 5.8 TWh over the lifetime of these driers.

If heat pump driers are not promoted, the ban of class C driers effective since November 2015 could lead to more instead of less energy consumed. Due to small efficiency differences and larger average capacity, class B driers have a higher average declared energy consumption than class C driers. Energy can be saved if consumers are convinced to buy heat pump driers instead of switching to inefficient class B driers. Communicating the total operating costs over the products' lifetime could be a measure, or rebate programmes making these appliances more affordable. The review of Ecodesign and Energy Label regulations that is due in 2017 should aim at introducing new MEPS at the least life cycle cost (LLCC) point and ban class B driers. Due to the big differences on national markets sufficient transition time will be needed.

Based on a longer study [2], this paper demonstrates the potential of **sales-based market monitoring**. Data such as presented here allows evaluating policies, spotting market trends and provides a sound basis for decisions on future policies. The future product database in Europe will bring a big improvement over today's situation by providing information on models that are on the market. Also in the future, sales data could complement the product information from the database, to weight products according to their relevance on the market. Australia shows how these two sources of information can be combined to get a comprehensive picture of the market [9]. While the product database will take several years until it is operative, sales-based market monitoring can start now.

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