Energy efficiency of consumer electronics and household appliances in the European Union: market statistics on rescaled energy efficiency classes

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Keywords

Energy Labelling Directive, efficiency classification, television, washing machines, dishwashers

Abstract

In July 2017, the European Commission published the revised Energy Labelling Regulation (2017/1369/EU), setting deadlines for rescaling the current energy efficiency classes and introducing a product database. As this database is not yet accessible for statistical analysis as of mid 2021, market data is derived by other means, namely an analysis of a price comparison website covering the market in Germany.

The main objectives of the paper are twofold. First, we analyse market data and shed light on the current EU market situation and energy class distributions for the product groups covered by revised energy labels. Second, for selected product groups, we perform more detailed analyses, taking into account specific parameters of the labels and product information sheets (e.g. TV screen size, washing machine capacity, etc.). The analysis will allow us to address several questions, such as: What is the current EU market situation? How does the energy efficiency class distribution look like after the label revision? Are the best classes – as intended by the regulation – unpopulated at the beginning, incentivizing product improvement in coming years? Does the distribution vary as a function of product specific features?

The analysis shows that the various product groups perform very differently on the new energy efficiency scale: Dishwashers make good use of most of the scale and still leave room for incentivising innovation as class A devices are not yet on the market. The situation for washing machines is different: Here more than 40 % of all models are right now already in the best performing classes A and B. Television sets populate the lower end of the scale with the majority of devices in class G, leaving the better classes for monitors.

In future, continuous monitoring of market developments will be possible and this paper is meant to analyse the initial status as of spring 2021 as reference for these future evaluations.

Introduction

In order to improve the environmental performance of energy-related products, the EU has put in place different Regulations and Directives. On the one hand, the Eco-design Directive 2009/125/EC [1] addresses this problem by 'pushing' the market towards more environmental friendly (in particular, more energy efficient) products by removing the worst performing ones from the market. On the other hand, the Energy Labelling Directive 2010/30/EU [2] 'pulls' the market towards more energy efficient products through energy labels. Energy labels inform consumers about the energy efficiency and other resource use of products, thereby reducing information asymmetries and encouraging customers to buy more energy efficient products. 79 % of all Europeans are influenced in their purchase decisions when buying appliances, according to a 2019 survey [3].

The Eco-design Directive and the Energy Labelling Directive have shown to be successful in the past and helped to reduce overall energy consumption coming from energy-related products. At the same time, the European Commission identified untapped potential for energy savings and reducing other environmental impacts in its evaluation of the Directives in

2015 [4]. One of the listed shortcomings was related to non-compliance with product-specific requirements, in part related to weak enforcement by national market surveillance authorities (MSA), estimated to be responsible for around 10 % of the reduction in potential energy savings.

So far, MSA in the EU had to request product specific information from manufacturers each time they inspect a product. The evaluation document states that this remedy could be partly addressed by a central product registration database as it has been put in place in other countries before. However, the introduction of such a database required a change to the Energy Labelling Directive, which happened in the 2017 revision.

The EU Framework Regulation 2017/1369 [5] for energy labelling, in force since 1 August 2017, has replaced EU Energy Labelling Directive 2010/30/EU. While the scope of the new Regulation has remained essentially unchanged, the new framework regulation foresees the introduction of a pan-European product database for all products covered by energy labelling regulations, including imported second-hand products. Such a database has been set up by the European Commission in recent years under the term EPREL, the European Product Registry for Energy Labelling [5].

Since 1 January 2019, before placing on the market a unit of a new model covered by a delegated act, suppliers have to enter relevant product information in the new EU Product Registration database for Energy Labelling (EPREL). With the revision of the energy label for fridges, washing machines, dishwashers, electronic displays (including television sets and monitors) and refrigerating appliances with a direct sales function as of 1 March 2021 the EPREL database is also accessible publicly. Entry point is through scanning the QR-code on a new energy label, leading directly to the database entry of this particular product. Additional functionalities, such as search tools and access to the database through an API (Application Programming Interface), are announced to be made available in the EPREL database later in 2021.

This paper intends to answer the question, if the new rescaled label provides good orientation for the consumer, which products can be considered best in class. Furthermore, consumers usually look for specific features, such as display sizes of a television set or if a washing machine is a top loader or a front loader. Analysing such market segments separately helps to give consumers further clarity. On the example of the German market such statistical evidence is provided, drawing data from a leading price comparison portal, which is assumed to cover the market comprehensively.

The new Energy Label

A revision of the existing energy label classification was needed as for several product groups, products were available only or mostly in the top classes. What constitutes a top class differed from product group to product group and could be anything between classes A to A+++. As a result, when consumers compared labels across different product groups, they could be led to believe that better energy classes exist for a particular label than those that are displayed [5]. This situation triggered the need for a rescaling of existing labels, in order to ensure a homogeneous A to G scale. The positive effect of such a rescaling actually has been confirmed by consumer research [6]. According to the explicitly formulated intention of EU Framework Regulation 2017/1369 "newly rescaled label should leave the top class empty to encourage technological progress, provide for regulatory stability, limit the frequency of rescaling and enable ever more efficient products to be developed and recognised. In exceptional cases, where technology is expected to develop more rapidly, no products should fall within the top two classes at the moment of introduction of the newly rescaled label." Indicatively, a timescale of approximately 10 years as a frequency for rescaling is intended. More precisely, a rescaling shall be considered, once "30 % of the units of models belonging to a product group sold within the Union market fall into the top energy efficiency class A and further technological development can be expected; or 50 % of the units of models belonging to a product group sold within the Union market fall into the top two energy efficiency classes A and B and further technological development can be expected." (Article 11, points 6 and 7, (EU) 2017/1369.)

Product group specific regulations have been adopted in late 2019 (Table 1[1, 2]). The rescaled and redesigned energy labels for those product groups where the new label took effect on 1 March 2021 are depicted in Figure 1 and Figure 2. The QR code leading to the EPREL product entry is placed in the top right corner of the labels (I). The energy efficiency scale ranges for all product groups now from A to G (IV). Energy consumption is stated below the scale (VI). Pictograms indicate further performance criteria to be displayed on the label.

Despite the relabelling requirement since 1 March 2021, there are still products in these product groups, which are sold with the old label: If a product is no longer placed on the market, the retailer may continue to sell the device with the previous energy label even until 9 months after the deadline[3]. Suppliers are exempt from the obligation to test expiring models according to any new test conditions. As with the revised regulations for all product groups analysed in this paper actually the test procedures have been adapted to reflect better actual real-life use or to take into account technological changes, this exemption for products placed on the market only before 1 March 2021 applies to all product groups.

The rescaled and revised energy label for light sources will be introduced 1 September 2021. For light sources different transition conditions apply. No statistical data is available for light sources, how the spread across energy efficiency classes will look exactly after the rescaled label is introduced. This remains to be analysed after 1 September 2021.

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1. Weighted energy consumption of the eco 40–60 programme at the rated washing capacity, half of the rated washing capacity and a quarter of the rated washing capacity compared to its standard energy consumption: for household washing machines and the washing cycle of household washer-dryers.

2. Weighted energy consumption of the wash and dry cycle at the rated capacity and half of the rated capacity compared to its standard cycle energy consumption: for the complete cycle of household washer-dryers.

3. According to Article 11.13(b)(ii) of (EU) 2017/1369 the following applies: "if the non-rescaled and the rescaled label require different testing of the model, the supplier is exempt from the obligation to supply a rescaled label for units placed on the market or put into service before the four month period [i.e., in the period four months before the date specified in the relevant delegated act for starting the display of the rescaled label], if no units belonging to same model or equivalent models are placed on the market or put into service after the start of the four-month period. In that case, the dealer shall be permitted to sell those units exclusively with the non-rescaled label until nine months after the date [i.e., after March 1, 2021, for the products analysed in detail in this paper] specified in the relevant delegated act for starting the display of the rescaled label."

Table 1. Product groups with rescaled energy label.

| #	Product Group	Regulation	Rescaled label effective	Criteria for the energy efficiency classes A–G
1	Washing machines and washer-driers	Regulation (EU) 2019/2014	1 March 2021	Weighted energy consumption of the eco 40–60 programme at the rated washing capacity, half of the rated washing capacity and a quarter of the rated washing capacity compared to its standard energy consumption
				Weighted energy consumption of the wash and dry cycle at the rated capacity and half of the rated capacity compared to its standard cycle energy consumption
2	Dishwashers	Regulation (EU) 2019/2017		Eco programme energy consumption in relation to standard programme energy consumption
3	Electronic displays	Regulation (EU) 2019/2013		Power demand in on mode correlated with the viewing surface area
4	Refrigerators	Regulation (EU) 2019/2016		Annual energy consumption in relation a defined standard annual energy consumption
5	Light sources	Regulation (EU) 2019/2015	1 September 2021	Total mains efficacy (useful luminous flux in relation to on-mode power consumption)
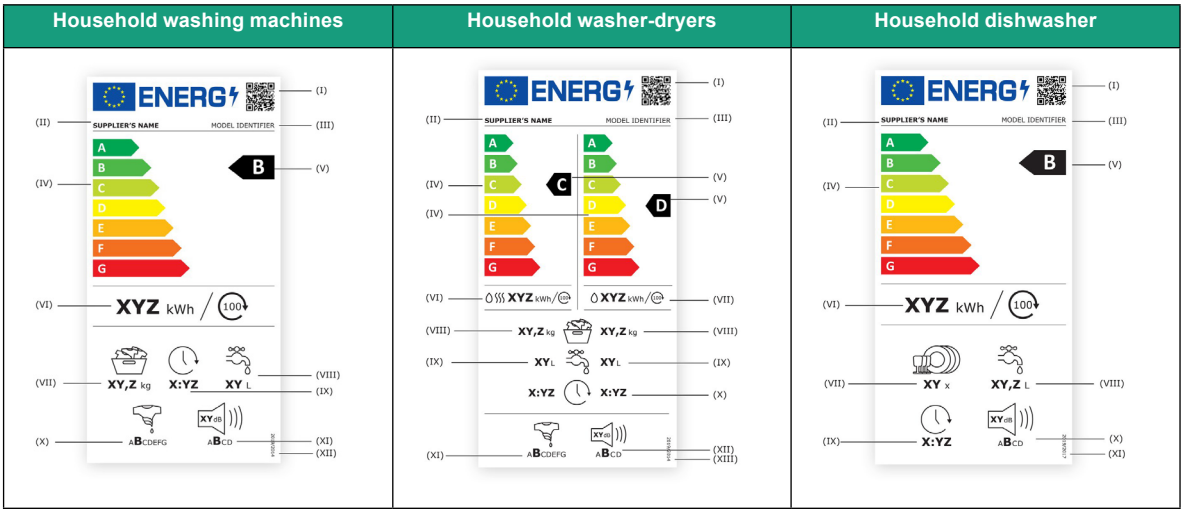
Figure 1. Rescaled energy labels, effective as of 1 March 2021.
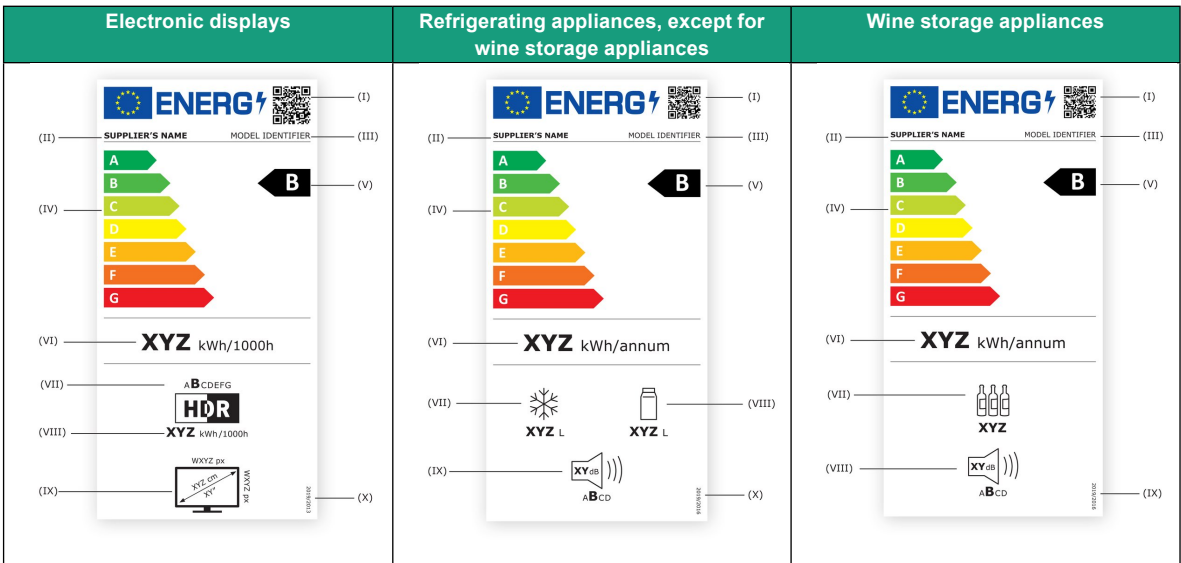

Figure 2. Rescaled energy labels (continued), effective as of 1 March 2021.

Table 2. Product group analysis – combined searches for deriving market shares.

#	Product Group	Sub-group	Total number of covered models	Criterion 1	Criterion 2
1	(EU) 2019/2014 Washing machines and washer-driers	Washing machines	748	Energy Efficiency Class	All models
					Capacity: up to 7 kg/above 7 kg
					Type: top loader/front loader
					Price: up to €500/above €500
		Washer-driers		Not analysed	
2	(EU) 2019/2017 Dishwashers		819	Energy Efficiency Class	All models
					Capacity dishes: up to 12/above 12
					Water consumption: up to 8.9 l/above 8.9 l
3	(EU) 2019/2013 Electronic displays	Television sets	825	Energy Efficiency Class	All models
					Display technology: LED/QLED, OLED
					Size ranges (diagonal): 32–48"/49"–55"/58"–100"
		Other monitors/displays		Energy Efficiency Class	All models (qualitatively only)
4	(EU) 2019/2016 Refrigerators			Not analysed	
5	(EU) 2019/2015 Light sources			Not analysed	
All			2,392		

Market statistics regarding energy efficiency classes

METHODOLOGY

As the EPREL database does not yet allow for extracting data for statistical purposes, market data is derived indirectly from a major German price comparison portal, www.billiger.de, which provides a comprehensive overview of most products being available online on the German market. Through the embedded search function on the website of the price comparison model the energy efficiency classes have been combined with individual technical or performance parameters to extract the number of product models meeting a certain combination. Technical or performance parameters have been selected with ranges to get a larger number of models meeting a given combination. All combinations analysed in this paper are listed in Table 2 per product group. In total the presented data is based on 2,392 models, for which the new energy efficiency classes are stated and are searchable on the price comparison platform.

With such a data pool only limited statistical analyses are feasible: The energy efficiency classes represent an ordinal scale, in statistical terms, and as such no regression analysis, calculation of arithmetic means or standard deviation or similar is feasible. A regression analysis of the numeric Energy Efficiency Index versus other parameters would be admissible, but the EEI is not searchable on price comparison portals and thus would require a manual data gathering, web crawler algorithms – or the EPREL data base, where such data will be available. Therefore, such kind of statistical evaluation is not feasible with the currently easy accessible data, but is recommended for future research, once EPREL allows for statistical evaluations.

A similar approach has been followed to analyse the status of the market for television sets in 2019 [7]. As also online retail-

ers are obliged to depict the new labels, such a portal can serve as a source of statistical data. Such an approach inevitably faces following limitations:

- Transition to the new rescaled label is not yet fully implemented by all online retailers and a random check shows some data flaws.

- Data is partly incomplete, as the price comparison portal does not always list a full set of the analysed parameters (such as number of dishes or water consumption in the case of dishwashers) and thus these models do not show up for the given parameter in the search feature, which leads to the effect, that statistics for individual features analysed below do not always add up to the stated totals.

- Only the German market is covered, and although this is the largest market within the EU 27, data for other markets might deviate. Data for other markets is not available from the analysed source, but might be derived from price comparison portals of other countries.

- Statistics can only be derived on a "per model" basis, not reflecting sales volume of individual models[4].

- Among online retailers non-compliance regarding labelling requirements has been found to be more common than stores [8].

For the product groups covered by the revised label this price comparison portal lists several hundred models each, which is considered a sound basis for such a statistical analysis. Double

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4. The same limitation applies to any later statistical analysis of the EPREL database as no sales volume is included in the declaration requirements.
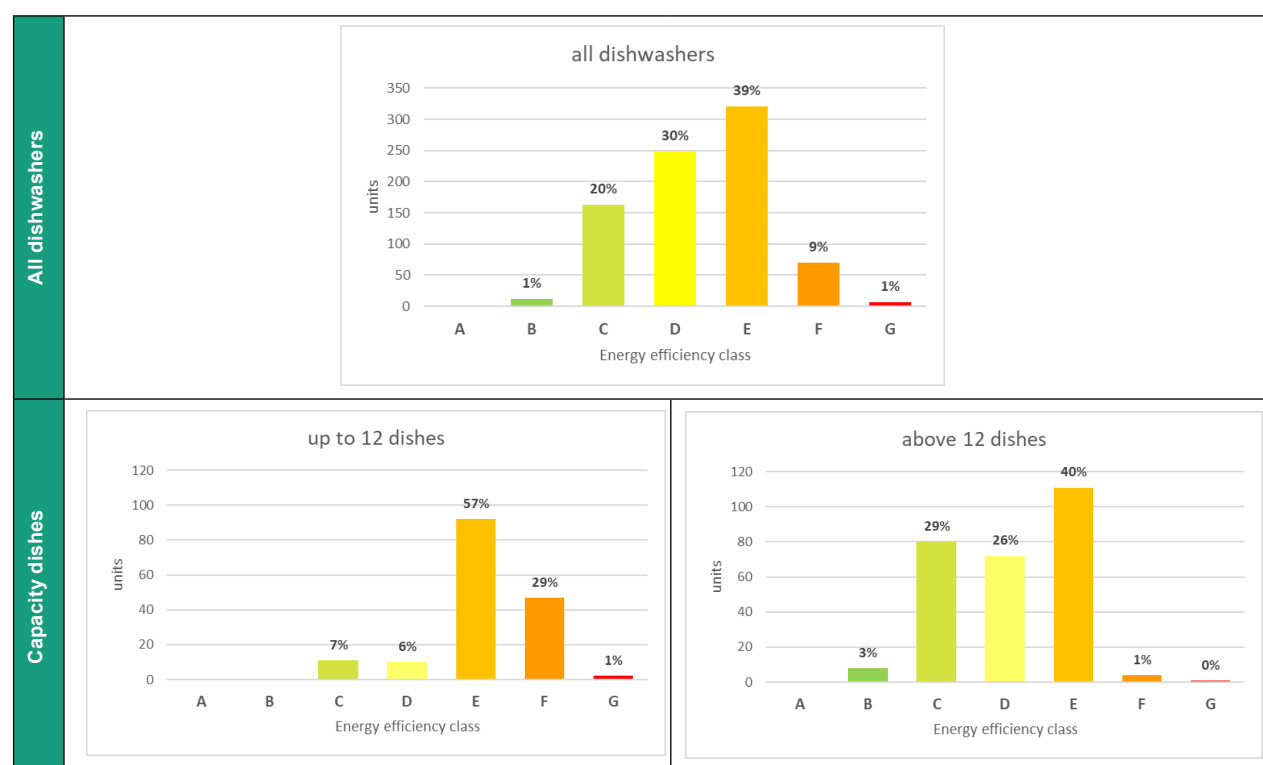
Figure 3. Dishwashers — Energy efficiency class distribution (parameters: all dishwashers and capacity dishes).

counting of some models, which might be listed differently by different retailers, might however occur.

Given the above exemption for relabelling of a product, which is not any longer placed on the market for the first time, but the retailer still sells devices available on stock, there is in parallel a declaration of old and new energy efficiency classes. We sorted out those products being still labelled with the old label version. Consequently, analysed statistical data refers only to those products, where units are placed on the market also after 1 March 2021.

Data refers to products listed on www.billiger.de as of 7 April 2021 (washing machines and television sets) and of 9 May 2021 (dishwashers). This analysis is conducted for dishwashers, washing machines, television sets and as a qualitative screening for monitors, which are covered by the same regulation as TV sets.

DISHWASHERS

In total www.billiger.de lists 819 different models of dishwashers, which are labelled with the rescaled energy label.

Only 1 % of all dishwasher models listed on the price comparison website are in energy efficiency class B, whereas the following classes are populated with increasing shares of the market. 39 % of all models are in class E. Energy efficiency class F still covers 9 % of all dishwashers, whereas only 1 % (8 models) are in class G (Figure 3).

With a view at specific technical criteria, the larger units with a capacity of more than 12 dishes are better represented in the better energy efficiency classes than the smaller units. However, also dishwashers with a capacity up to 12 dishes can reach energy efficiency class C (5 % of the models).

The eco-design regulation for household dishwashers (EU) 2019/2022 requires as from 1 March 2024 onwards a mini-

mum Energy Efficiency Index for dishwashers with a rated capacity equal to or more than 10 place settings corresponding to class E. According to the current market situation this second tier is already met by most models, but not all: 33 models with a capacity of 10 dishes or more are still in classes F and G[5].

The water consumption of more than half of the dishwasher models is in a rather narrow band of 8.9 to 9.5 l under the specified test conditions. Correlating the energy efficiency class with the water consumption shows no clear trend: Although 36 % of all models with a water consumption in the lower range of the spectrum (below 8.9 l) are in the rather good class C, and a much lower C class share in the mid-range segment, the few B class dishwashers are actually found in this mid-range segment. Among the dishwashers with an above median water consumption only few models are in class B and the majority is represented by class E. Overall, this data shows, that dishwashers with high water consumption can be in better energy efficiency classes – and vice versa. Although there is a tendency that lower water consumption means better energy efficiency class, this is not a strong correlation. This leads to the conclusion, that depicting water consumption as an environmental performance parameter on the label is well justified, as it provides additional information, which is not well covered by the energy efficiency class alone.

The correlation of energy efficiency class and price analysed for dishwashers below refers to the lowest price from any retailer as stated on the price comparison portal. These prices are explicitly not understood to be average prices. Looking at

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5. As of May 21, 2021.

Figure 4. Dishwashers – energy efficiency class distribution (parameters: water consumption and price segments).

the various price segments from low prices to higher prices shows a very clear trend: Low price devices are found in the 3 worst energy efficiency classes only. In the price segment above €700 60 % of the models are in classes B and C. Class E and F devices are occasionally found in the high-price segment. These statistics show that consumers looking for energy efficient dishwashers will find them increasingly in the higher price segments.

With this spread of the market over the energy efficiency scale from A to G the targets of the revision process – see chapter "The new Energy Label" – are actually met: A broader range of classes is populated right from the beginning, but the top class is still empty and even energy efficiency class B sees only very few models momentarily. For consumers the label is likely to provide the intended guidance. Products in energy efficiency class B can be considered current top-runners. However, these products are to be found in the high-price segment. A shortcoming of the current A–G scale is the fact,

that the G class is almost obsolete right from the introduction of the rescaled label.

WASHING MACHINES

In total www.billiger.de lists 748 different models of washing machines, which are labelled with the rescaled energy label.

18 % of all household washing machines listed on the price comparison website in class A, and 24 % in class B (Figure 5). Also classes C and D are on a similar level with 22 % and 24 % respectively. The share of products in classes E to G is much lower, and actually there are currently only two models with the energy efficiency class G.

The eco-design regulation for household washing machines and household washer-dryers (EU) 2019/2023 requires as from 1 March 2024 onwards a minimum Energy Efficiency Index for household washing machines with a rated capacity higher than 3 kg corresponding to class E. Classes F and G are then not allowed for these devices anymore. According to the current
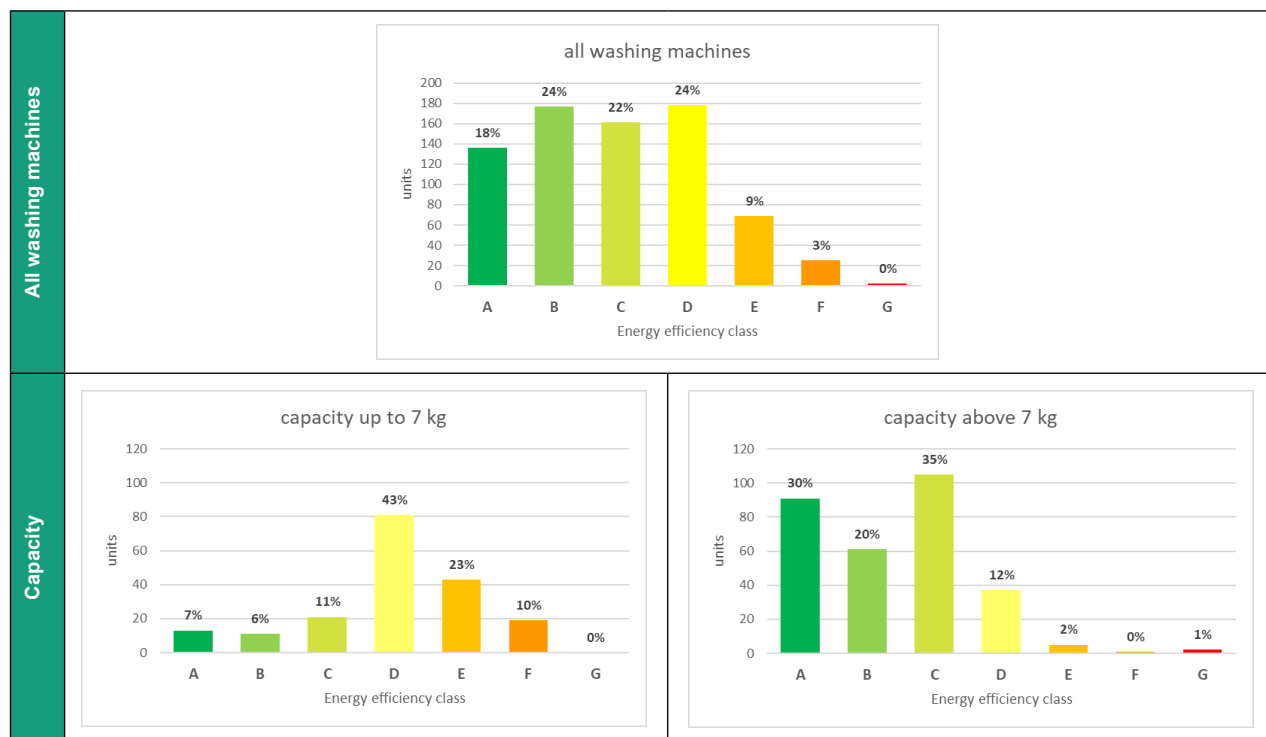
Figure 5. Household washing machines – energy efficiency class distribution (parameters: all washing machines and capacity).
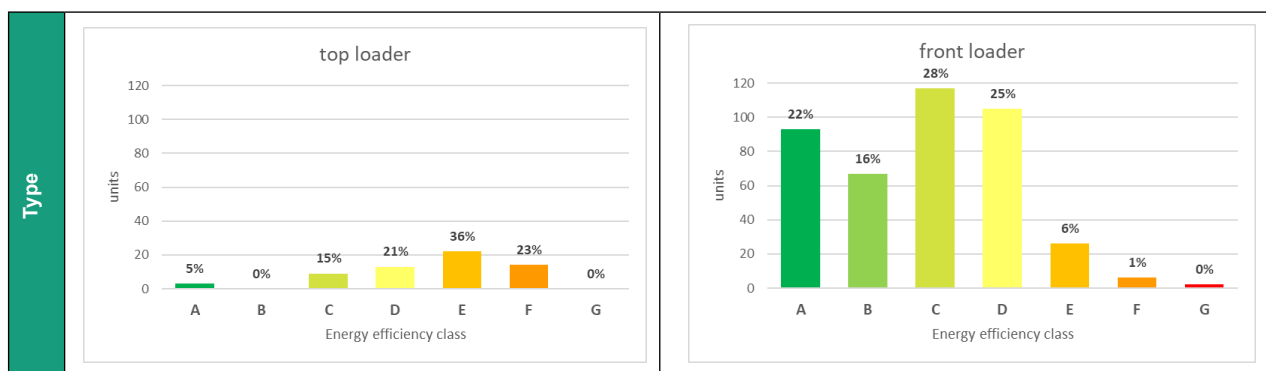

Figure 6. Household washing machines – energy efficiency class distribution (parameters: top loader vs. front loader).

market situation this second tier is already met by most models, but not all: 22 models with a capacity above 3 kg or more are still in classes F and G[6].

With a view at specific technical criteria it is apparent that this rather high share of products in the better energy efficiency classes stems mainly from washing machines with a capacity of more than 7 kg laundry and front loaders. Among smaller washing machines with a capacity below 7 kg energy efficiency class D is by far dominating with 43 % of all models. A similar tendency of better energy efficiency classes for washing machines with higher capacity was already observed with the former A+++ to D scale, as the related calculation of the Energy Efficiency Index made it relatively easier for large machines to reach better energy efficiency classes. This was partly due to test settings measuring energy consumption with a load high-

er than actually observed in market surveys. For this reason a changed test setting representing better real user behaviour in terms of load was introduced with the revision of the label [9]. According to current data under the revised test settings washing machines with higher capacity still reach in average significantly better energy efficiency classes.

The market in Europe is dominated by front loader washing machines and top loaders are a minor market segment (13 % of all models according to this analysis). Among top loaders the most populated energy efficiency class even shifts to E (36 %). This is relevant for those consumers, who specifically look for top loaders, as for them what constitutes an energy efficient machine in the market segment of their choice means something different than for those who look for front loaders.

From this analysis the conclusion has to be drawn that the revision of the energy label for washing machines failed to meet two major targets: The top class A is not empty and represents even almost one quarter of the total market and products are
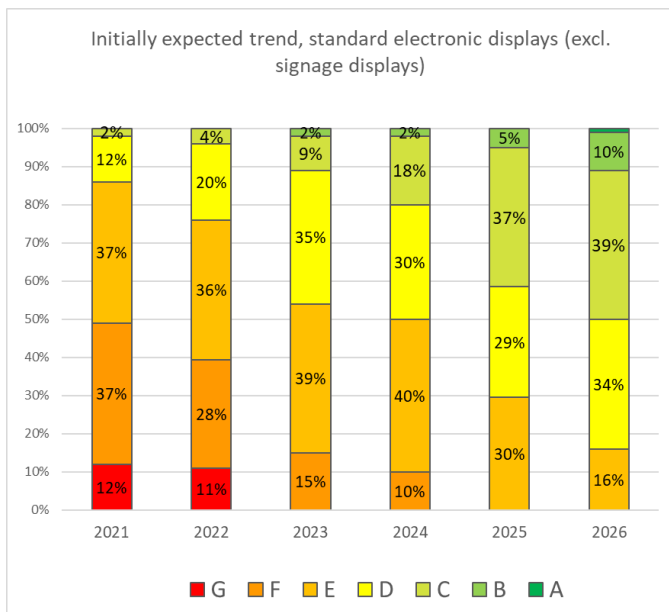
6. As of May 21, 2021.

Figure 7. Initially expected development energy label classes of standard electronic displays.

not evenly spread over the remaining scale, as energy efficiency class G is irrelevant right from the introduction of this label and also in classes E and F there are only few models. With 42 % of all models being in classes A and B the point where a next revision should be considered, i.e. 30 % in class A or 50 % in class A and B combined, might be reached in a not too far future.

TELEVISION SETS

As per explanatory memorandum of the eco-design regulation for electronic displays [10] the expected trend in terms of energy efficiency class distribution was as depicted in Figure 7[7], including monitors, but excluding signage displays. Only a share of 12 % of standard electronic displays where supposed to be in class G. Class B products have been expected to enter the market in 2023, class A devices in 2026.

From 1 March 2023 onwards the eco-design regulation (EU) 2019/2021 for electronic displays introduces a second tier of requirements, largely banning class G displays[8].

The following market analysis refer to television sets only, not the full scope of the labelling regulation. In total www.billiger.de lists 825 different models of television sets, which are labelled with the rescaled energy label. The vast majority of all television sets (70 %, i.e. almost 600 models) are in energy efficiency class G currently (Figure 6). 25 % of the TV sets are in class F and another 5 % in class E. 2 models are in energy efficiency class D, which represents the current top class as there are no products in classes A to C as of April 2021. With a view at specific technical criteria the better classes E and F are populated with LED display television sets. QLED and OLED technology is found in energy efficiency class G only, with very few exemptions.

The size of the display is crucial for overall energy consumption, but the equation to calculate the Energy Efficiency Index (EEIlabel) of electronic displays correlates the energy consumption with the viewing surface area as performance parameter.

With this approach larger displays with a larger absolute energy consumption can be in the same or even a better energy efficiency class than a smaller device with lower energy consumption.

Statistics unveil however, that products in energy efficiency classes E and F are rather the smaller devices with a diagonal of up to 48". Approximately 90 % of the television sets with screen sizes 49" upwards are in class G momentarily.

This analysis clearly shows that with the introduction of the rescaled energy efficiency label there is only little differentiation in the market of television sets and class E devices can be considered best in class in terms of energy efficiency. For the consumer the new energy efficiency label provides only limited guidance. Another aim of the rescaling is however met: The new scale leaves enough room for innovation towards further energy efficiency increases in future.

Furthermore, the analysis suggests, that the equation to calculate the EEI favours smaller television sets, thus products with an overall lower energy consumption, which was the intention when calibrating the formula to calculate the Energy Efficiency Index already when the EU Energy Label for television sets was introduced first in 2011 [11].

MONITORS

Monitors are covered under the same Regulation (EU) 2019/2013 for electronic displays as television sets, but there is a very large share of products listed on the price comparison platform as monitors, which actually already have been covered by the prior regulation 1062/2010 on television sets as "television monitors" and which apparently make use of the exemption for products still being on sale, but not placed on the market. The search tool on the website does not allow for a systematic search of new labels, thus a statistical analysis is not feasible with limited effort. However, random checks of individual models allow for a verification, whether the old or new energy efficiency classes are stated. Such random checks unveiled however, that there are several models from at least 3 vendors reaching energy efficiency class B and the same is the case for class C. No devices in the rescaled energy efficiency class A has been found. Energy efficiency classes F and G are dominating by far.

Conclusion

The market overview which can be extracted from data on price comparison platforms allows for a first evaluation of the revised product group specific regulations and to derive some statistics, which are presented in this paper: Rescaling of the label for dishwashers worked as intended, as most energy efficiency classes are well populated, but not the top class A, leaving room for future improvement. Consumers should get appropriate orientation with this label. The situation is different for washing machines, where already now a substantial share of products is in the best classes. For television sets the opposite is the case: Most products are now in energy efficiency class G. This overall picture and unbalanced population of energy efficiency classes

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7. Shown scenario is the trend expected for the ECO proposal corresponds to the working documents presented to the Consultation Forum of July 2017, but does not fully reflect the actually adopted regulations.

8. As the calculation of the EEI in the eco-design regulation and the energy label regulation are not exactly the same, the 2023 tier does not fully align with the lower end of class F.
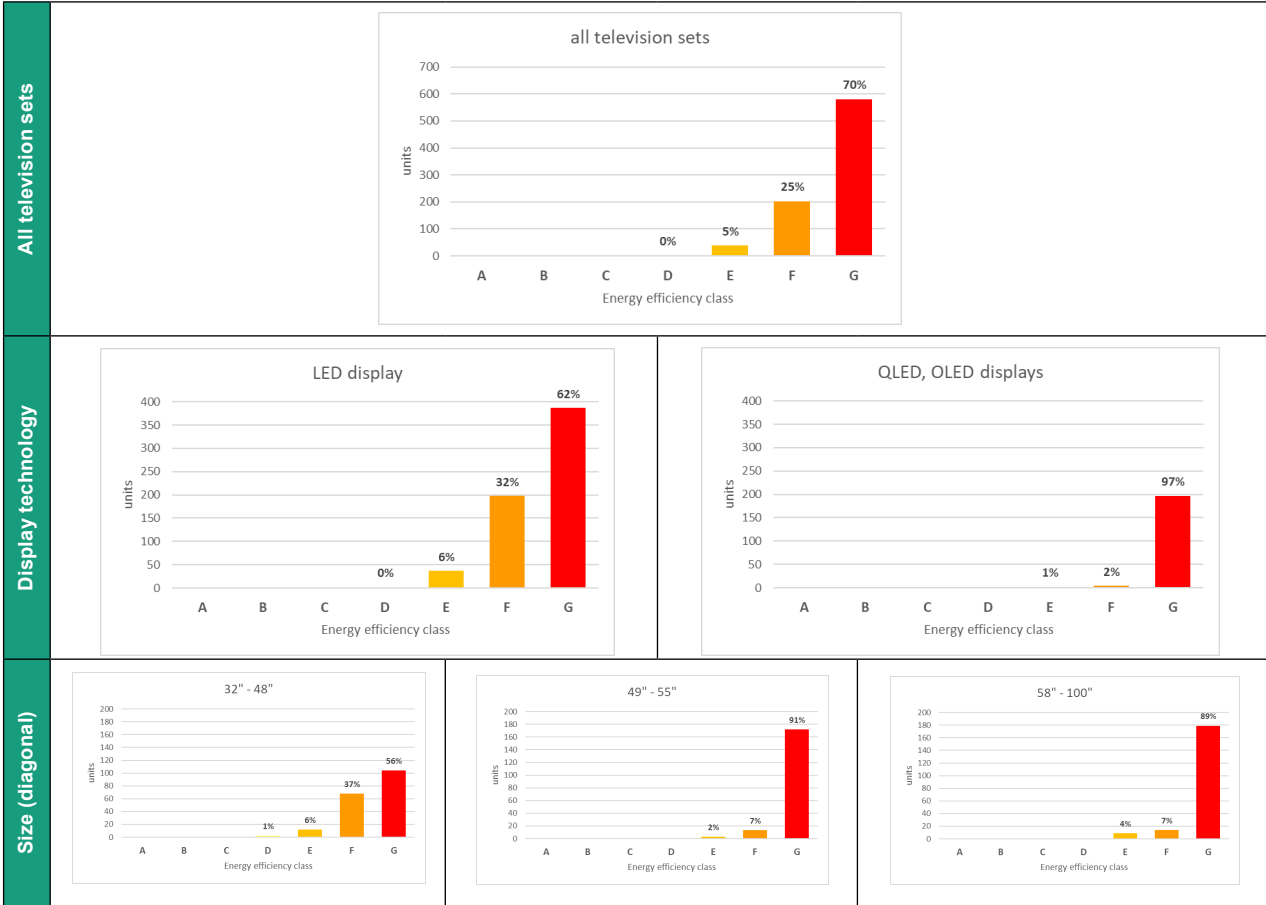
Figure 8. Television sets — energy efficiency class distribution.

might lead to major confusion for the consumer: A television set in energy efficiency class E is among the most energy efficient ones, but a washing machine in class E is among the worst performing ones in terms of energy consumption. A class B dishwasher is outstanding in terms of energy performance, but a class A washing machine can be anywhere in the best quarter of the market, but might not be an extremely good case in terms of energy efficiency.

For washing machines the current spread of models across energy efficiency classes already comes close to the point, where a next revision and tightening of the scale would be intended, according to the wording of Regulation (EU) 2017/1369. For television sets there is enough room for improvement to populate better energy efficiency classes in coming years.

The upcoming next tier of tighter specific eco-design requirements in 2023 is largely already met by the markets of dishwashers and washing machines, whereas for television sets the situation is different: A large share of the market as of 2021 will not meet the 2023 requirements anymore. As of now, this seems to be particularly challenging for rather new display technologies, such as QLED and OLED TV sets, and for the larger display sizes.

Outlook

With the introduction of rescaled energy labels for the first few product groups on the European Union market on 1 March 2020 for the first time the EPREL product database is accessible for the public. As features are limited by now, this database does not yet unfold its full potential to create optimal transparency in the market and for consumers. This situation will improve in the coming months as new user-friendly features will be implemented and third parties will be able to develop software tools to extract relevant information for consumers [12].

The overall success of the energy label as a policy tool to create transparency on energy efficiency and to pull the market towards better products triggers an even broader introduction of energy labels, potentially combined with material efficiency aspects. Such an approach is even considered currently for mobile phones, although the power consumption is much lower than that of appliances or TV sets. However, the fact that an efficient use of power provided by the battery leads to an extended battery lifetime might justify a label for such mobile products as well [13].

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