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Follow-up of the preparatory study for Ecodesign and Energy Label for Household Dishwashers

Final report

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GLOSSARY

Cleaning Class	The level of soil removal that an appliance is able to achieve. The cleaning class of the appliance is rated in terms of a set of cleaning classes from A to G. A being the best class, G the worst one.
Drying Class	The level of dryness that an appliance is able to achieve. The drying class of the appliance is rated in terms of a set of drying classes from A to G, being A the best class.
Eco programme	the most efficient cleaning programme or cycle, in terms of combined energy and water consumption, that is suitable to clean normally soiled tableware, and to which the information in the label and the product information sheet relates
Household dishwasher	a machine which cleans, rinses, and dries dishware, glassware, cutlery and cooking utensils by chemical, mechanical, thermal, and electric means, which may or may not have a specific drying operation at the end of the programme and which is designed for domestic use complying with the Low Voltage Directive 2014/35/EU as stated by the manufacturer in the Declaration of Conformity (DoC);
Independent operator	an undertaking other than authorised retailer and repairer which is directly or indirectly involved in the repair and maintenance of household dishwashers.
Place settings	set of crockery, glass and cutlery for use by one person
Programme	a series of operations that are pre-defined and are declared as suitable by the manufacturer for specified levels of soil or types of load, or both, and together form a complete cycle;
Programme time	the time that elapses from the initiation of the programme until the completion of the programme, excluding any end-user-programmed delay;
Rated capacity	the maximum number of place settings together with the serving pieces, as stated by the supplier, which can be treated in a household dishwasher on the programme selected, when loaded in accordance with the supplier's instructions
Spare part	a separate part that can replace a part with the same or similar function in an appliance. The part is considered necessary for use if the appliance cannot function as intended without that part. The functionality of the appliance is restored or is upgraded when the part is replaced by a spare part

CONTEXT OF THE PROPOSAL

1.1. Legal framework

The Ecodesign Framework Directive 2009/125/EC[1] establishes a framework for laying down ecodesign requirements for energy-related products. It is a key instrument of EU policy for improving energy efficiency and other environmental performance-related aspects of products in the internal market. Article 16 of the Ecodesign Directive lists priority products, including consumer electronics, office equipment and domestic appliances, that were identified by the Council and the European Parliament and for which the Commission was to consider the implementation of appropriate measures,. Household dishwashers belong to this list of priority product groups, and an Ecodesign regulation on dishwashers have been in place since 2010 (see below), which is now subject to update and review (as summarised in the Ecodesign Working Plan 2016-2019[2]).

The application of the Ecodesign Directive is complemented by the Energy Labelling Framework Regulation (EU) No 2017/1369[3], which establishes a framework for the provision of accurate, relevant and comparable information on the specific energy consumption of product groups and other environmental information, and facilitates consumer choice in favour of more resource-efficient products. Moreover, the EU Energy Label provides a dynamic incentive for manufacturers to improve other environmentally-relevant aspects of their products, in addition to energy efficiency, and to accelerate the market take-up of more efficient models.

The application of ecodesign and energy labelling requirements is complementary, in that ecodesign pushes the market upwards from minimum requirements, and energy labelling pulls the market towards best practice technologies. Therefore, a proposal for an ecodesign regulation of a specific product group is often accompanied by a proposal for a Delegated Act that defines energy labelling requirements for the same product group (provided that the corresponding option is confirmed by the Impact Assessment).

For ecodesign and energy labelling measures related to household dishwashers, the following regulations currently apply:

- Commission Regulation (EU) No 1016/2010 of 10 November 2010 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household dishwashers.
- Commission Delegated Regulation (EU) No 1059/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of household dishwashers.

1.2. Currently covered products

The regulations listed above cover electric mains-operated household dishwashers and electric mains-operated household dishwashers that can also be powered by batteries, including those for non-household use and for built-in appliances.

[1] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (OJ L 285, 31.10.2009, p. 10).

[2] Communication from the Commission: Ecodesign Working Plan 2016-2019, COM(2016) 773 final, Brussels, 30.11.2016

[3] Regulation (EU) 2017/1369 of the European Parliament and of the Council of 4 July 2017 setting a framework for energy labelling and repealing Directive 2010/30/EU., OJ L 198, 28.07.2017, p. 1)

1.3. Reasons for and objectives of the revision

The first energy labels for household dishwashers were based on Directive 92/75/EEC (European Council 1992), which, beginning in 1995, made it compulsory for certain electrical appliances to display an Energy Label that would help consumers choose more energy efficient appliances.

Commission Directive 97/17/EC established the first energy label for household dishwashers. The outcome of a further revision resulted in Commission Delegated Regulation 1059/2010, whose requirements remained in effect at the time of writing this report. In addition, in 2010, as the result of Commission Regulation 1016/2010, Ecodesign minimum requirements came into effect for household dishwashers. Both regulations were required to be revised in the light of technological progress no later than four years after their entry into force. For Ecodesign, the review was mandated to assess, in particular, verification tolerances for market surveillance purposes, opportunities for setting requirements on water consumption and the potential for hot water inlets.

Starting in 2014, the Commission has undertaken a study to review these two regulations on household dishwashers, the conclusions of which will be presented to stakeholders in the framework of the Consultation Forum established under Article 18 of the Ecodesign Directive 2009/125/EC.

2. CONSULTATION OF INTERESTED PARTIES

DG JRC led the revision process, a key element of which has been the (still ongoing) consultation of stakeholders, including the representatives of Member States, standardisation organisations, manufacturers and their associations, environmental non-governmental organisations (NGOs) and consumer organisations. An online communication system (BATIS) was set-up in order to facilitate the exchange of documents between registered stakeholders. In addition, progress and working documents have been made available to the general public and can be accessed at the following website: http://susproc.jrc.ec.europa.eu/Dishwashers/index.html .

Stakeholders also had the oportunity to actively contribute to the study by providing data, information and written feedback on technical and policy option questionnaires and working documents. Interaction with stakeholders also took place via three meetings organised by DG JRC:

- 1st meeting: 24 June 2015, in Seville.
- 2nd meeting: 18 November 2015, in Brussels.
- Webinar: 7 October 2016. The webinar was specifically dedicated to presenting and discussing possible material efficiency requirements for dishwashers (as well as washing machines and washer-dryers).

DG JRC received technical and scientific support from Oeko-Institut e.V. and the University of Bonn (Germany) for the development of the review study, and was granted access to the relevant appliance database of energy and water use (1997-2015) by the industry association CECED

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3. Review of the existing ecodesign and labelling measures

3.1. Markets and performance of household dishwashers

3.1.1. Market data and trends regarding the number of place settings

In 2014 the stock of household dishwashers in the EU-28 amounted to 95.4 million units (based on an average penetration rate of around 44% and a total number of households of 216.8 million). Total annual sales of household dishwashers were estimated to be 10.4 million units in 2014

The vast majority of dishwasher models on the European market are "full-size", with a width of 60 cm (compared to "slim-line" or "compact machines", with a width of 45 cm). Currently, the capacity of full-size dishwashers ranges from 12 to 15 place settings (ps) (see **Error! Reference source not found.**). The prevailing trend shows an increase in market share for dishwashers with a capacity greater than 12 ps. Between 1998, when the CECED database was created, up to 2013, 12 ps models dominated the dishwasher market. However, since 2005, their market share has steadily decreased (2005: 81.7%; 2013: 40.1% and 2014: 25.4%), while the market share of dishwashers with a capacity of 13 ps (2005: 0%; 2013: 31.1% and 2014: 31.2%) and 14 ps (2005: 0.6%; 2013: 10.9% and 2014: 23.3%) has increased. Further, in 2004 the first full-size models with a capacity of 15 ps entered the market (1.6%); their market share grew to 3.0% and 5.6% in 2013 and 2014, respectively. Between 2013 and 2014, the average rated capacity of dishwashers increased by 3.2%, resulting in an average capacity of 12.6 ps.

Since 2001, the share of slim-line models has remained constant (at 15% ± 3%) , even though their rated capacity has increased. In 2000, slim-line models with a capacity of 8 ps led this market segment, but since 2001, the capacity of the majority of slim-line models has been 9 ps. In 2001, slim-line models with a capacity of 10 ps entered the market, but so far they have not managed to make a breakthrough in terms of market share (4.1% in 2013). In 2013, the 9 ps slim-line models still dominated this market segment with 9% and 7.1% in 2014 of all dishwasher models sales. Since 2009, the market shares of certain slim-line models have remained constant: 4% (±2%) for 10 ps-models, 8% (±3%) for 9 ps-models and 0.5% (±0.2%) for 8 ps-models.

Dishwashers with a capacity of less than 8 ps (countertop or tabletop models) have a small but stable market share of between 0.5% and 1.5% of total sales. Whereas for many years 4 and 5 ps were common, in 2002 models with 6 ps entered the market. In 2010, 4 ps models and in 2011, 5 ps models disappeared from this segment of the market.

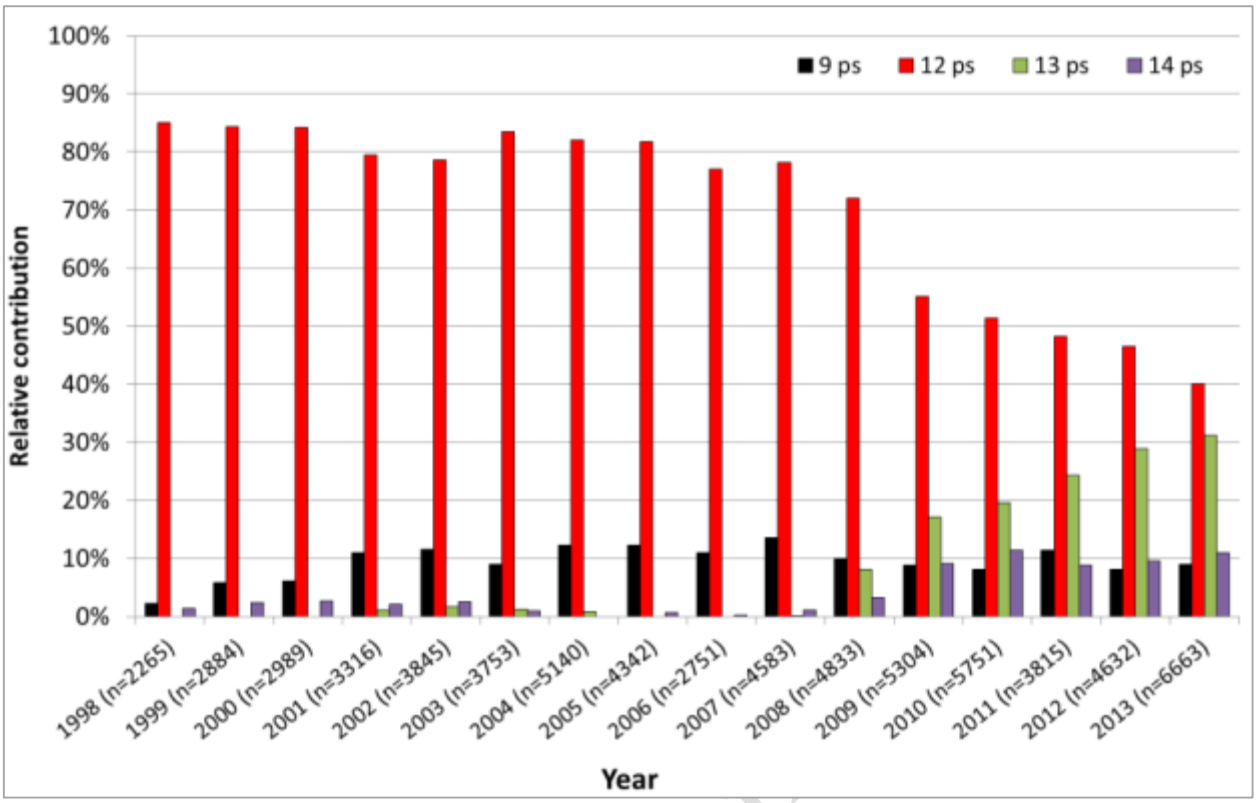


Figure 1: **Shift of market shares of dishwasher capacities (in ps = place settings, n = number of dishwasher models available on the European market in a certain year) [data from CECED, personal communication]**

3.1.2. Performance of household dishwashers

In 2014, the, total electricity and water consumption related to the use of household dishwashers in Europe was estimated to be 29.7 TWh/year and 298 million m³/year, respectively.

3.1.2.1. Energy efficiency classes and energy consumption

Error! Reference source not found. shows that, as of December 2013, only three label classes (i.e. A+, A++ and A+++) have been allowed on the EU market for dishwashers with ps ≥ 11 and, since December 2016, with ps ≤ 10. Note that EU Energy Label class A is only available for dishwashers with ps ≤ 7.

In 2013, around 10% of the dishwashers sold on the market were classified A+++.

Table 1: **Overview of the current Ecodesign and EU Energy Labelling requirements for household dishwashers and which classes are phased out**

EU Energy Label Class	EEI	Ecodesign Minimum Tier I - Dec 2011	Ecodesign Minimum Tier 2 - Dec 2013	Ecodesign Minimum Tier 3 - Dec 2016
A+++	EEI < 50			
A++	50 ≤ EEI < 56			
A+	56 ≤ EEI < 63			
A	63 ≤ EEI < 71		Allowed for ps = 10 and width < 45cm	Only allowed for ps ≤ 7

EU Energy Label Class	EEI	Ecodesign Minimum Tier I - Dec 2011	Ecodesign Minimum Tier 2 - Dec 2013	Ecodesign Minimum Tier 3 - Dec 2016
			Allowed for ps ≤ 10	
B	71 ≤ EEI < 80	Allowed for ps = 9, 10 and width < 45 cm	Banned for all machines	Banned for all machines
C	80 ≤ EEI < 90	Banned for all machines	Banned for all machines	Banned for all machines
D	EEI ≥ 90	Banned for all machines	Banned for all machines	Banned for all machines

Between 2010 and 2011, after Ecodesign Regulation (EC) No 1016/2010 came into force, the relative contribution of dishwasher models to certain energy efficiency classes changed (**Error! Reference source not found.**). Manufacturers sped ahead: although the regulation required all dishwasher models to fulfil, as a minimum, the requirements of energy efficiency class A as from December 2016, by 2011 nearly all dishwashers on the European market were already classified as energy efficiency class A. As might be expected, the share of dishwasher models with higher energy efficiency classes (A+++, A++ and A+) increased from 61% in 2011 to 82% in 2013. In 2014, around 94% of dishwashers were classified A+++, A++ or A+.

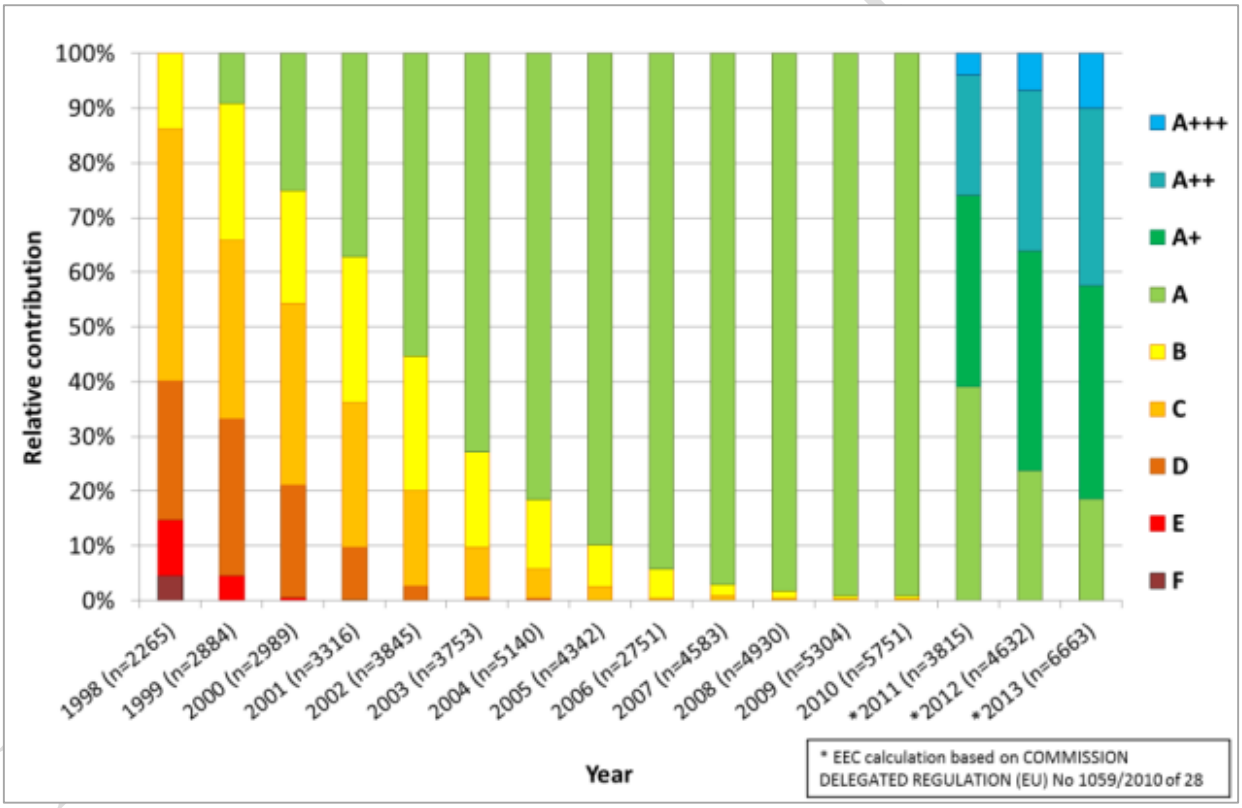


Figure 2: **Development of the distribution of dishwasher models with certain energy efficiency classes on the European market (data from CECED, personal communication)**

Differentiating energy efficiency classes according to model capacity, the following spread was observed for 2013 (**Error! Reference source not found.**): dishwashers with a capacity of 6 ps (countertop models) were only classified A and A+, slim-line models with 9 to 10 ps accounted for 16% class A++ and 1% A+++; for full-size models with 12 ps or more, 41% achieved A++ and 18% A+++. The market shifted

after Tier 2 (Dec. 2013) of the Ecodesign Regulation (EC) No 1016/2010 came into force, which solely permits models with ps ≤ 10 or width <45 cm to qualify for EU Energy Label class A. From December 2016, class A has been banned for all models (Ecodesign Tier 3).

Note that Figure 1, **Error! Reference source not found.** and **Error! Reference source not found.** show the number of models on the market. This does not necessarily reflect sales figures. In 2015, sales figures for EU Energy Label class A+++ models accounted for around 8% of all dishwashers.

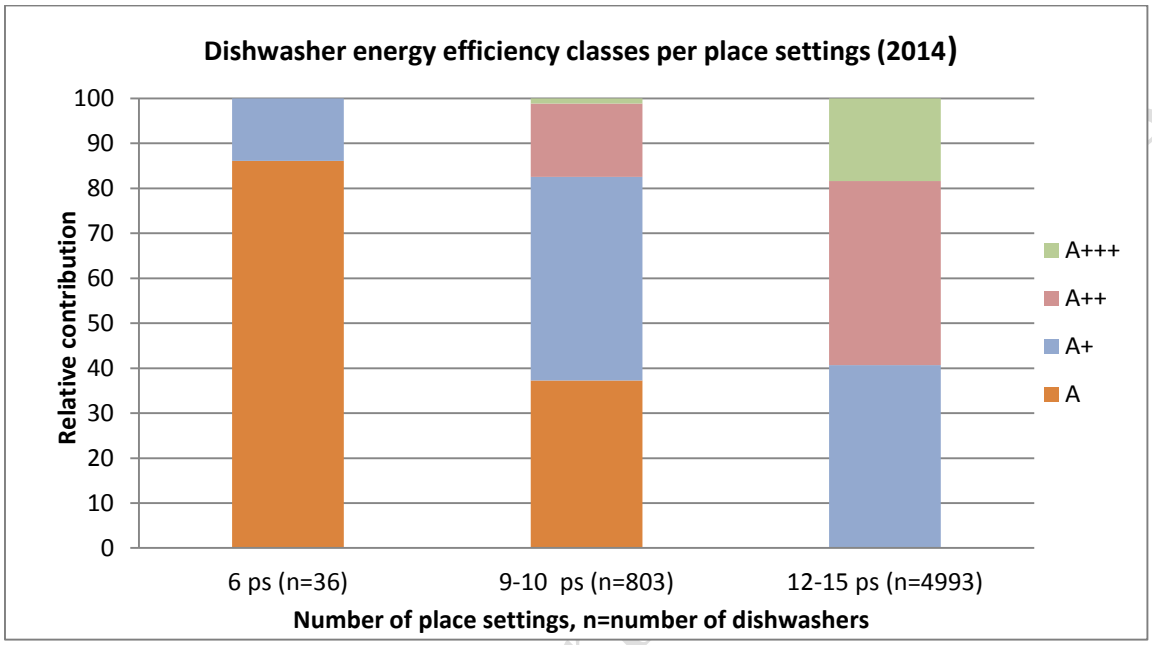
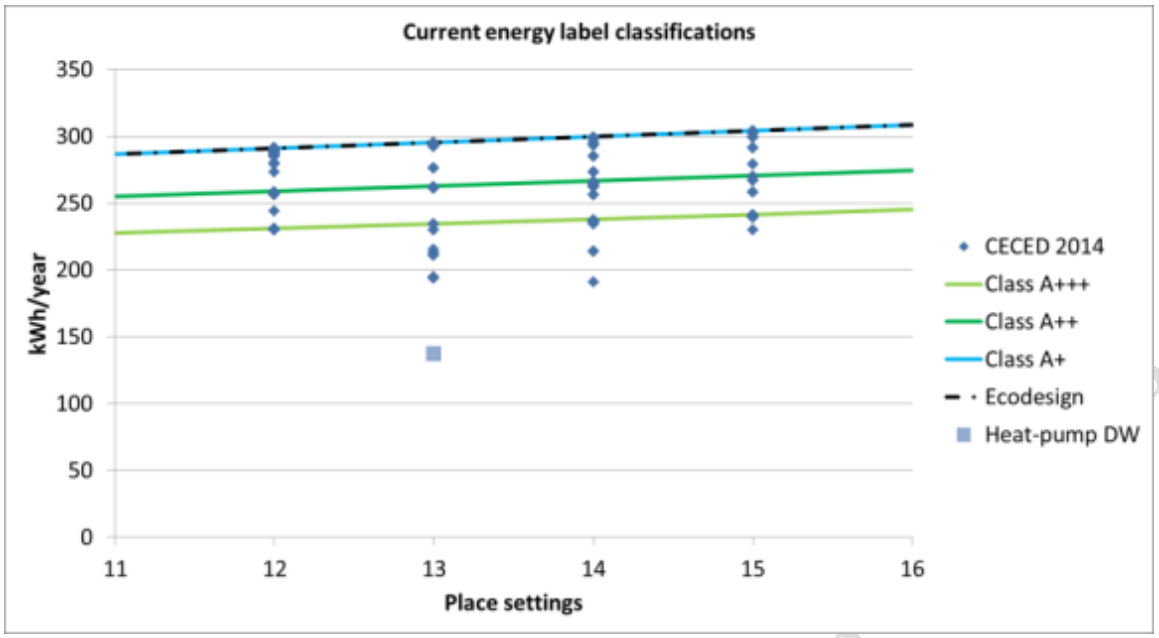


Figure 3: **Sales Distribution of models of dishwashers with different rated capacities into A to A+++ EU Energy Label classes on the European market (2014) (data from CECED, personal communication)**

Further, **Error! Reference source not found.** shows a sample of household dishwashers sold in the EU in 2014 (CECED database) with ps ≥ 11 together with the current EU Energy Label classes and ecodesign requirements. It shows that some dishwasher models already far exceed (i.e., have a lower energy consumption p.a. [kWh/ year]) th requirements of EU Energy Label class A+++, especially for appliances equipped with a heat pump. However, it should be noted that the figure shows yearly energy consumption under standard conditions (i.e. the so-called "Eco programme"[4]). However, under real-life conditions, the improvement potential via the application of a heat pump is lower.

[4] ECO programme means the most efficient cleaning programme or cycle, in terms of combined energy and water consumption, that is suitable to clean normally soiled tableware, and to which the information in the label and the product information sheet relates



Note that energy consumption is based on the standard (Eco) programme only.

Figure 4: **Yearly energy consumption of dishwasher models on the market in 2014 as function of place settings for ps ≥ 11 together with the current EU Energy Label classes and Ecodesign requirements. When only the standard (Eco) programme is used for comparison purposes, a heat pump equipped dishwasher is taken as the reference for the most efficient dishwasher on the market.**

Due to the history of Ecodesign and Energy Label requirements for dishwashers, the current minimum energy performance requirements are seem tobe at a high level nowadays. However, the abundacy of models classify with the highest energy class might indicate that the technological advances are not fully exploited. The EU Energy Label classes thus need to be revised, in order to maintain an ongoing forward-looking incentive for manufacturers to continue improving their appliances.

For household dishwashers, the average specific energy consumption of the standard programmes has been reduced by 34% from 1.43 kWh per cycle in 1998 to 0.94 kWh per cycle in 2014, as shown in Figure 5.

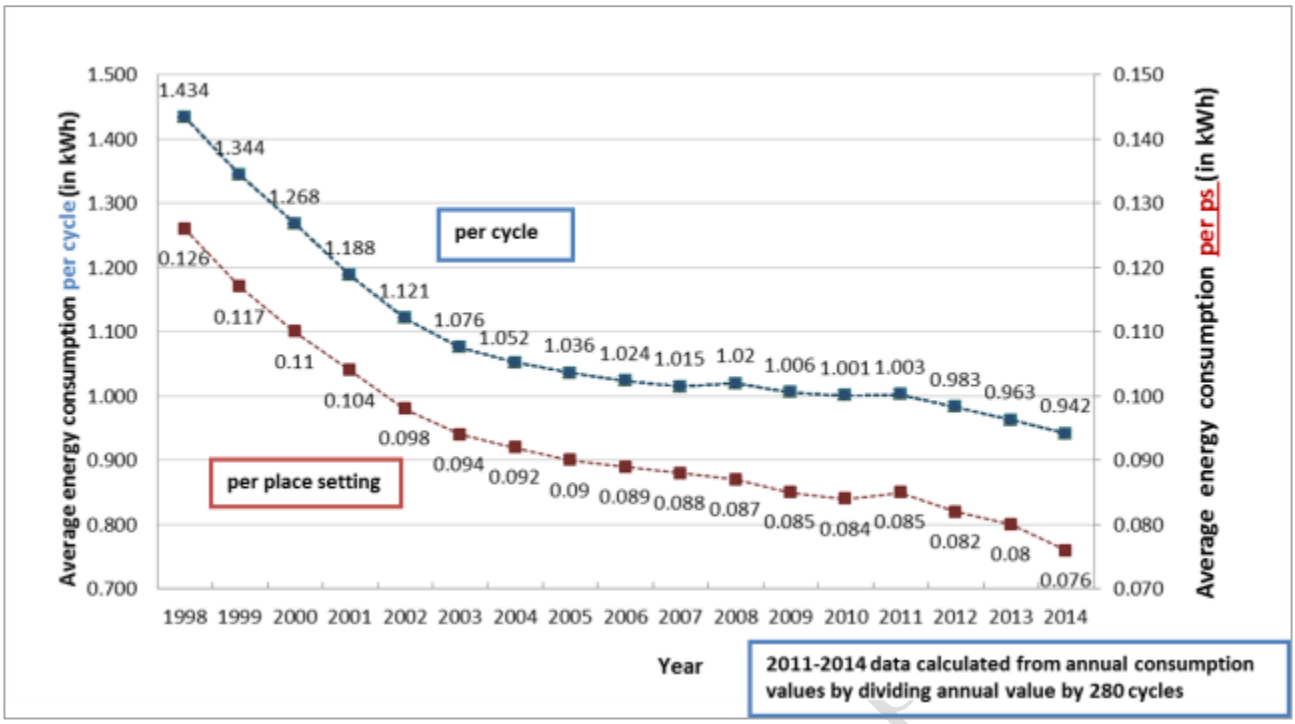


Figure 5: **Development of average energy consumption per cycle or per ps of the Eco programme (data from CECED, personal communication)**

Error! Reference source not found. shows that the energy consumption per ps of larger appliances (12-15 ps) is generally lower than that of smaller sized dishwashers.

Table 2: **Energy consumption of dishwashers with different capacities in 2014 (data from CECED (2014))**

Number of ps	Annual energy consumption (kWh/year)	Energy consumption per cycle (kWh/cycle)	Energy consumption per standard ps (kWh/cycle/ps)
6	191.78	0.68	0.11
9	225.87	0.81	0.09
10	245.35	0.88	0.09
12	280.28	1.00	0.08
13	267.90	0.96	0.07
14	259.08	0.93	0.07
15	272.76	0.97	0.06

3.1.2.2. Water consumption

Water consumption per cycle was reduced by 46% from 19.14 litres per cycle in 1998 to 10.34 l/cycle in 2014 (see Figure 6). Besides technical advances, water consumption savings are achieved through variations in programme courses, e.g. omitting the pre-rinse phase or re-using final rinse water for the pre-rinse of the following dishwashing cycle. Water consumption is closely related to energy consumption.

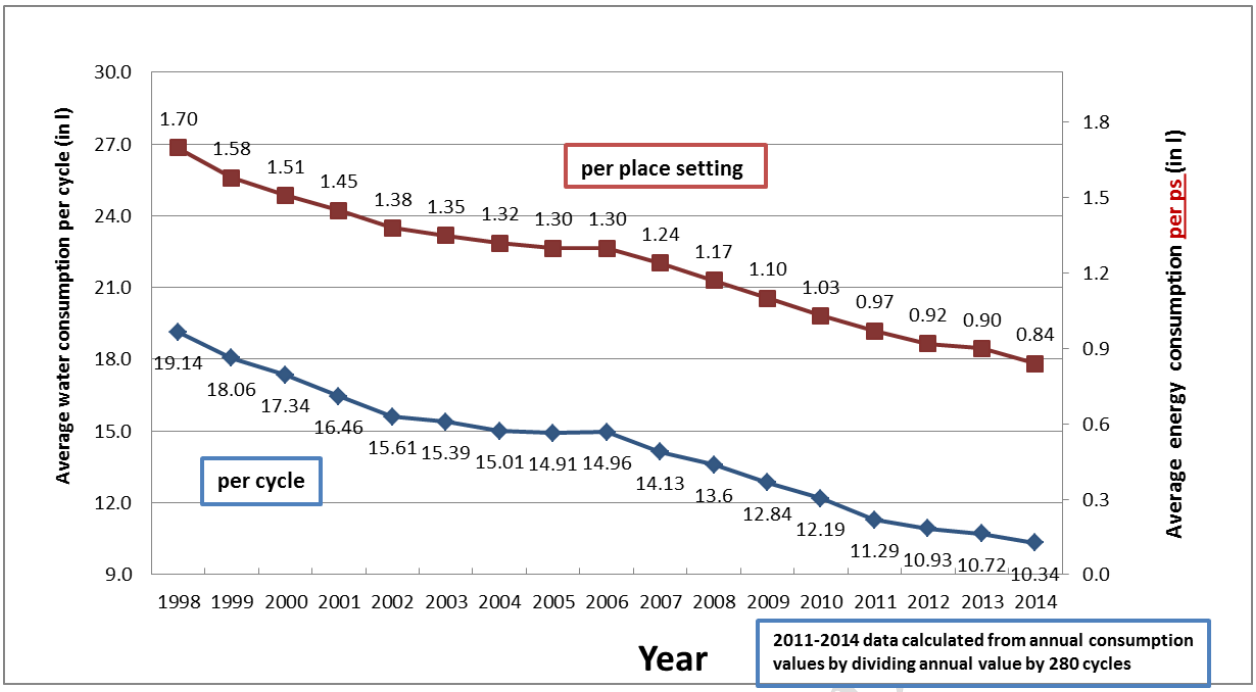


Figure 6: **Development of average water consumption per cycle or per ps in the Eco programme (data from CECED, personal communication)**

As for water consumption per ps, Table 3 shows that water consumption per ps of larger appliances (especially 13-15 ps) is considerably lower than that of small sized dishwashers.

Table 3: **Water consumption of dishwashers with different capacities in 2014 (data from CECED (2014)**

Number of ps	Annual water consumption (L/year)	Water consumption per cycle (L/cycle)	Water consumption per standard ps (L/cycle/ps)
6	2 213	7.90	1.32
9	2 704	9.66	1.07
10	2 885	10.30	1.03
12	3 221	11.51	0.96
13	2 733	9.76	0.75
14	2 825	10.09	0.72
15	3 038	10.85	0.72

3.1.2.3. Cleaning and drying performance

Savings in energy and water consumption have been realised without adversely impacting the cleaning and drying performance of dishwashers. These performance parameters have even improved, as shown in Figure 7 (cleaning performance) and Figure 8 (drying performance).

According to the requirements of Ecodesign Regulation (EC) No. 1016/2010, *all* dishwasher models on the European market had to meet the requirements of cleaning-performance class A as from December 2011. Since this change took place in 2011, and because the cleaning-performance class is no longer displayed on the energy label for dishwashers, database entries end in 2010. This does not mean, that cleaning

performance is not longer verified by market surveillance as this requirement reminds as an Ecodesing reguirement

In addition, the share of dishwasher models with drying performance class A continually increased. In 2014, 99.6% of the dishwasher models on the European market fulfilled the expected requirements. Ecodesign Regulation (EC) No 1016/2010 requires that, as from December 2013, *all* dishwasher models, except countertops with ps < 8, must meet drying performance class A. (Note that the 0.4% of dishwashers that did not reach drying performance class A in 2014 were dishwashers with 6 ps).

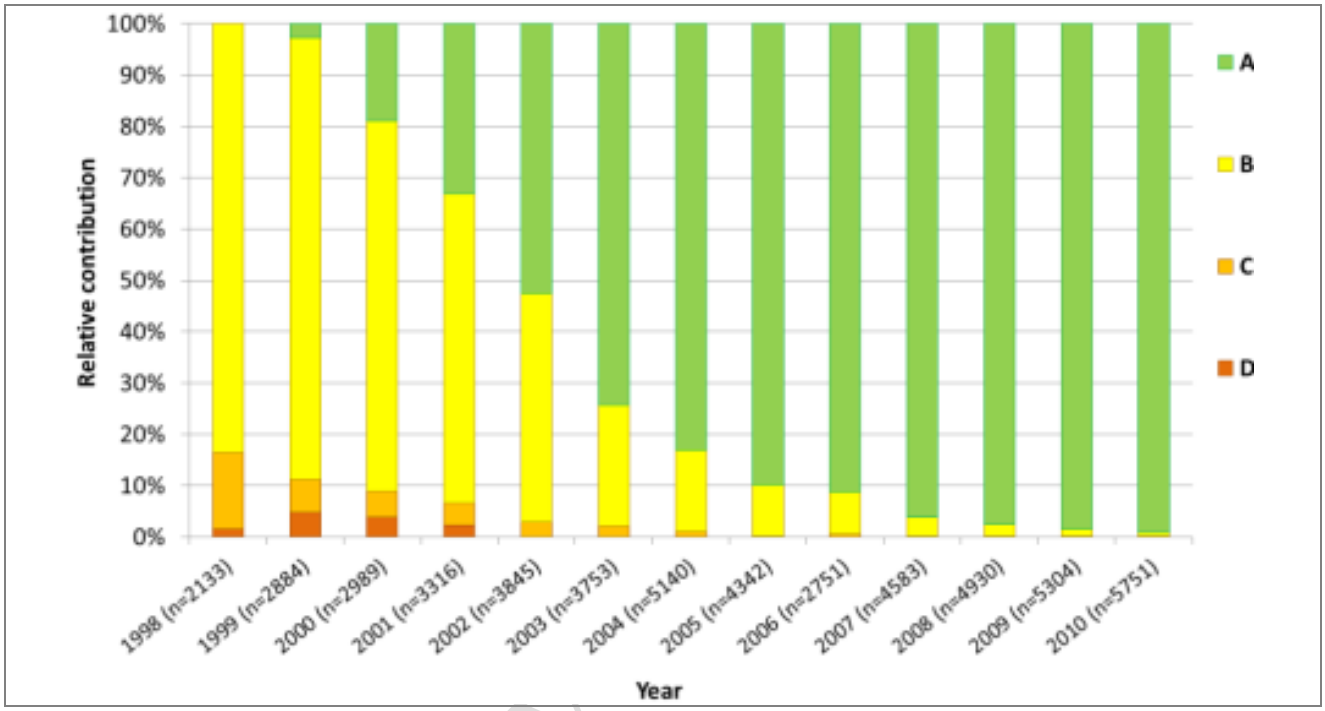


Figure 7: **Development of the distribution of dishwasher models of certain cleaning performance classes (data from CECED, personal communication). Note that class A has been obligatory for cleaning performance since December 2011.**

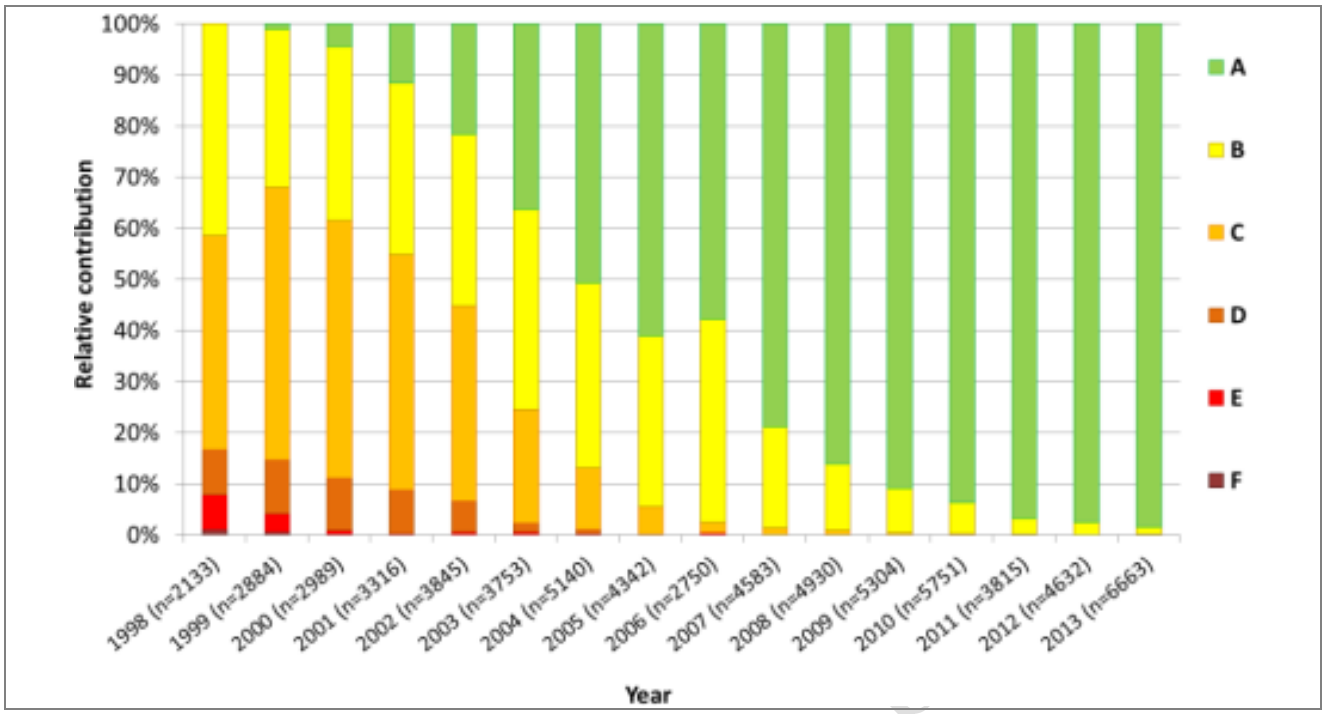


Figure 8: **Development of the distribution of dishwasher models of certain drying performance classes (data from CECED, personal communication). Note that since December 2013, drying- performance class A has been obligatory for ps > 8, and class B for ps < 8.**

Since 2010, improvements in cleaning performances at lower consumption values have been primarily due to changes in the "Eco" programme. According to the context of the so-called "Sinner's circle"[5], the same cleaning performance can be obtained with reduced water temperatures (which correspond to a lower energy consumption) if the duration of the cleaning phase is prolonged. With longer programme durations, residues left on plates etc are able to soak in the detergent/ water mix for a longer period of time, and also the exposure times of the dishwasher contents to the automatic dishwashing detergent and the mechanical forces of the water jets are prolonged. To comply with the cleaning performance requirement, a minimum water temperature of the washing water has to be reached in order to dissolve fat content.

Technical improvements (increased ventilation, sorptive drying methods, auto open function etc.), as well as reduced water temperatures in the hot rinse cycle, with a simultaneous prolongation of the drying phase of a dishwasher programme, have also contributed to a reduced energy demand in the drying process, at the same time as achieving improvements in drying performance.

3.1.3. Consumer behaviour

In 2015, a European-wide consumer survey on household dishwashers was conducted. The main survey results were:

[5] According to the Sinner Circle the cleaning process is based on 4 factors: mechanics, temperature, chemistry and time. These factors depend on each other, i.e. one factor cannot be reduced without increasing another one when maintaining the same cleaning efficiency. In comparison to hand dishwashing, in an automatic dishwasher all factors are of similar importance

- The breakdown of the cleaning programmes that consumers use is as follows: 39 % of the cycles are run in normal programmes, 19 % in Eco programmes, 11 % in short programmes, 9 % in intensive programmes and 9% in automatic programmes. While it is difficult to fully quantify the effect of having the Eco programme as a default (required since December 2012), the share of consumers that choose the Eco programme as their regularly-used programme appears to be increasing. This is supported by data that show that the Eco programme is used more often in newer machines. Therefore, it is proposed that the Eco programme remains as the basis for energy label and ecodesign requirements.
- Programme duration: consumers indicate that they are willing to use energy-saving programmes, but that programmes that last too long (> 3-4 hours) are not acceptable. This shows that consumers might not be well informed about the relationship between programme time and energy savings: usually programmes with a longer duration save more energy. The highest acceptance of longer programme times is found in households with newer machines. This possibly indicates that, when provided, energy saving programmes with longer cycle times could increasingly have a greater acceptance by users. Additionally, consumers are interested in being informed about the duration of energy-saving programmes on the Energy Label. Therefore, it is proposed to indicate the programme time of the most efficient cycle for normally-soiled tableware (i.e. the Eco programme) on the revised EU Energy Label.
- The six most important features that consumers would take into account before purchasing a dishwasher were, in descending order, '*Low energy and water consumption and associated bills*', '*Good cleaning performance'*, '*Purchase price'*, '*Long lifetime can be expected'*, '*Low noise emissions'* and '*Simple and easy to use'*.
- On the energy label, it is preferable to display energy and water consumption per cycle instead of per year.
- 61% of the consumer survey participants wanted to retain the indication of noise emissions on the energy label. Noise emissions were rated as the second most important of the criteria displayed on the energy label, after the energy efficiency class per se.

3.1.4. Technological improvement potential

Different technological improvement options were analysed as part of the review study. The improvements were compared to base cases with 13 ps and 10 ps, which cover both standard-size and slim-line dishwashers.

For **single design options**, the biggest differences were observed after the options 'installation of a heat pump' or 'application of adsorption technology'. These design options produced relatively high savings (between 5% to 13%) in the following impact categories: total energy and electricity consumption, hazardous waste, GWP, acidification (only adsorption technology) and VOC emissions. However, dishwashers with a heat pump had a high additional impact in the following categories: process water, non-hazardous waste, persistent organic pollutants (POPs) and heavy metals (both to air and to water), which vary between 13% and 74% of the overall impacts. The use of adsorption technology had a medium additional impact in cooling water and heavy metals (both to air and to water) of between 6% and 18%. The increase of these impacts is attributed to the additional inputs and processes during the production phase (i.e. higher material consumption).

The design options 'automatic door opening' or 'fan' resulted in medium savings between 5% and 8% in the impact categories of total energy and electricity consumption, cooling water, hazardous waste, GWP, acidification and VOC emissions. The differences in the other impact categories were small to negligible. Small savings of 2% to 4% were observed for the design options including 'heat exchanger', 'advanced sensors' and 'consumer feedback mechanisms' for impact categories total energy and electricity

consumption, hazardous waste, GWP, acidification and VOC emissions. The differences in the other impact categories were even smaller.

The differences observed for the design option 'moderate increase of programme duration' were not significant, as they did not exceed 1%.

The life cycle costs for all the single design options, except the heat pump option, were very similar. They ranged from -3% to +1% of the life cycle cost (LCC) of the base case. Taking into account uncertainties, especially of the cost data, the differences were not significant. The single design option with the highest LCC was the heat pump, which was mainly due to the much higher purchase price compared to the base case (+73%). The overall LCC increased by 15% to 21% (depending on the assumptions related to the purchase price). However, this high purchase price is to some extent compensated for by the savings in electricity costs (-14%) during the use phase of the dishwashers. The reductions in electricity consumption and the respective costs were estimated by assuming a mix of programmes, which reflect consumer behaviour.

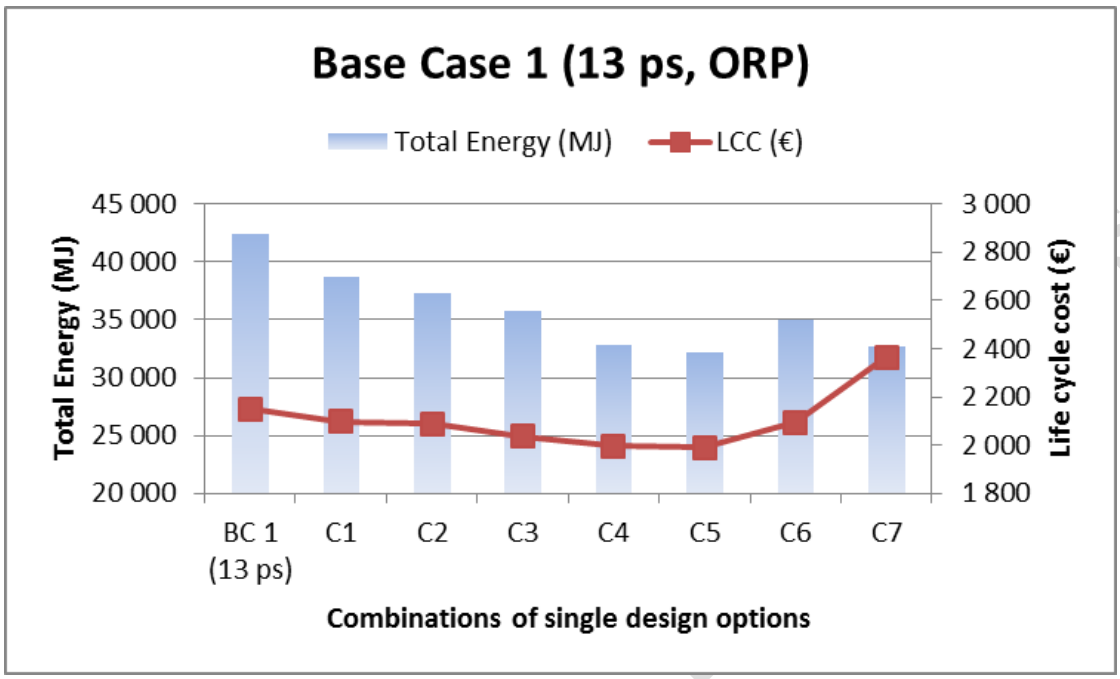
The changes of the environmental impacts and costs due to the inclusion of the design options for the slim-line base case (with 10 ps) were very similar to those of the standard base case (with 13 ps), with the exception that, in the case of slim-line dishwashers, the heat pump was not considered because of possible space limitations.

Following the recommendation of the EU Ecodesign Regulation (EC) No 1016/2010 for household dishwashers, the review study specifically analysed the **potential for hot water inlets**. The review study concluded that potential benefits of hot-water-inlet appliances depend on the specific site conditions and parameters, such as the length and insulation of the hot water pipe, efficiency and control characteristics of the circulation pump, and the efficiency of the water heating sources (e.g. gas boiler, off-peak electric, solar combined with gas or electric, etc). Further, the potential savings depend on the dishwasher technology. For example, when using dishwashers with Zeolith® drying technology or with a (water tank) condenser for drying, the savings from using hot water filling are lower compared to the savings of other types of dishwashers. Also the already low water consumption of dishwashers reduces the savings potential related to heating the water used. Today, in general, only 6-8 litres of water are heated per cycle (split into two intakes), i.e., the amount of water taken each time is between 3-4 litres. This means that the pipe length between the hot water generation/circulation pipe and the dishwasher needs to be very short, otherwise the heat losses due to the hot water that is cooling down – i.e., remaining within the pipes - outweigh the benefits of the alternative heating system.

Regarding **combinations of improvement options** for household dishwashers, the review study revealed that (see Figure 9 and Figure 10):

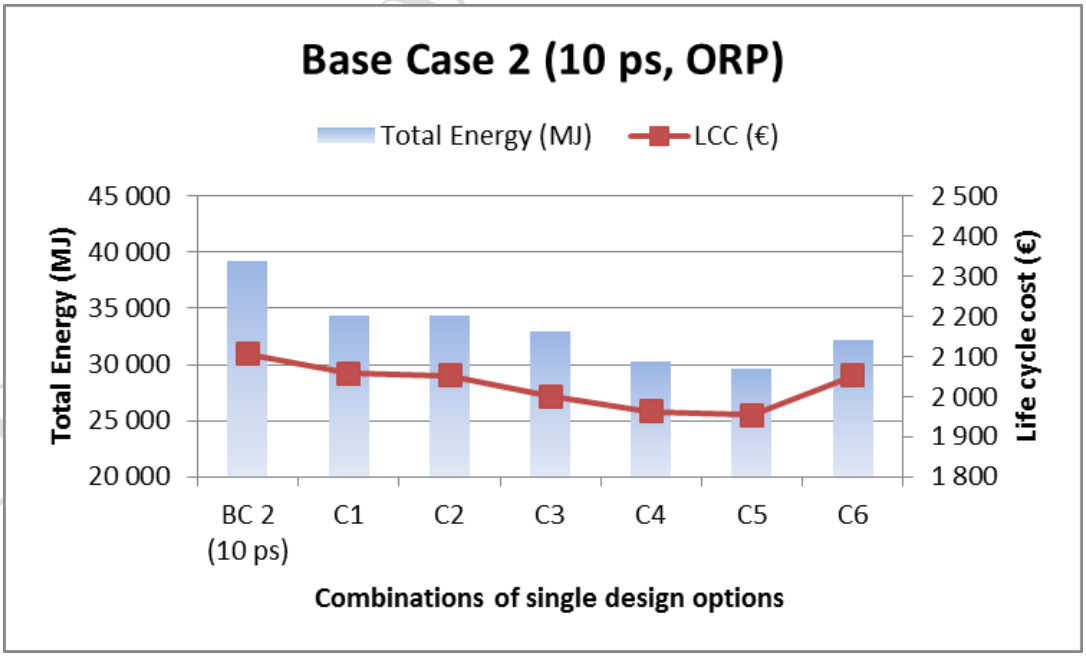
- For both base cases (13 ps and 10 ps), the total energy consumption decreases from design options combination C1 (fan plus automatic door opening) to combination C5 (longer programme duration, fan, automatic door opening, improved sensors, heat exchanger, and consumer feedback mechanisms).
- Combination C5 is the best available combination of single design options in terms of energy savings and lowest life cycle costs (LLCC).
- Combination C6 is a model combining the following design options: longer programme duration, improved sensors, consumer feedback mechanisms, heat exchanger, and adsorption technology. C6 shows a slightly higher energy consumption (between that of Combinations C3 and C4).
- Combination C7 is a model that combines the following design options: longer programme duration, fan, automatic door opening, improved sensors, consumer feedback mechanisms, and the use of a heat pump. Combination C7 is not possible for slim-line dishwashers (base case 2

with 10ps). The total energy consumption of C7 is between that of Combinations C4 and C5. However, the LCC of a model with a heat pump increases compared to the base case.



Note that the vertical axes do not start from zero.

Figure 9: **LCC for the combinations of design options together with the total energy consumption over the lifetime for Base Case 1 (13 ps) taking into account the observed retail price (ORP)**



Note that the vertical axes do not start from zero.

Figure 10: **LCC for the combinations of design options together with the total energy consumption over the lifetime for Base Case 2 (10 ps) taking into account the observed retail price (ORP)**

3.1.5. Resource efficiency aspects

With regard to the resource efficiency of household dishwashers, the results of the review study revealed the following:

- The average technical product lifetime of household dishwashers (i.e. first useful service life of a machine replaced due to a defect) is 12.5 years. Therefore dishwashers are still relatively long-lasting products compared to other electric and electronic equipment (EEE). Moreover, attention should be drawn to the increasing share of consumers who replace still-functioning appliances in order to have a better device. A German consumer study (Prakash et al. 2016) showed that, in 2012, 18% of all dishwashers that were replaced on the basis of a consumer's desire for a better model were *less than 5 years old* (while in 2004 this was around 13%).
- The same study shows that the proportion of household dishwashers that have to be replaced earlier than the expected-average lifetime due to an appliance defect has increased from 2004 to 2012, especially for defects that occur within the first 5 years of ownership,.
- It is difficult to assign reasons for breakdowns to common components in dishwashers. The causes of breakdowns vary, stemming from sources such as the motor, circulation and drain pumps, electronics, the timer, hoses, etc.
- For household dishwashers, the use pattern or, at times, misuse of the appliance by consumers might lead to defects in the device appearing earlier than envisaged, e.g.
  - Consumers' extensive adoption of low temperature programmes, as well as the insufficient use or lack of use of detergents, may lead to fat deposition and blockage of tubing;
  - excessive leftovers/scraps on dishes may block filters and drain pumps;
  - broken/damaged glasses and/or dishes may block filters and pumps;
  - cutlery and large dishes, if not well-positioned inside the device, may block or even damage the spray arms;
  - lack of proper maintenance by the users (e.g. not cleaning the filters sufficiently, or not performing decalcification sufficiently regularly).
- Reparability of household dishwashers seems to have become more difficult in new devices. The work of reuse and repair centres is hindered by the lack of access to, and the cost of spare parts, a lack of access to service manuals, software and hardware, as well as product designs that sometimes hinder appliance disassembly and, thus, the undertaking of the required repairs.
- Over time, repairing dishwashers has become less attractive to consumers. Where a defect occurs, appliances are increasingly discarded, even though repairing them might have increased the products' lifetimes. Reasons for not repairing a device seem to be related to the relatively high costs of repair compared to the relatively low price of purchasing a new appliance.
- In addition to the above issues, Tecchio et al. (2016) collected data on the early replacement of household dishwashers when consumers mistakenly believed the appliance to be defective. The study reported that approximately 10% of the machines that reached the repair services had no failures, or at least that no failure was found. However, these machines did not perform well, possibly due to blocked drainage (outside the device/in the wall), or where the water tap had become closed or defective, in cases where the power plug was off, or a child safety lock had been activated, or electronics that became wet and subsequently dried out, or other reasons.
- Regarding end of life (EoL) management, dishwashers are subject to established recycling processes in accredited Waste Electrcial and Electronic Equipment (WEEE) installations. Appliances with heat pumps should be processed separately for depollution (extraction and incineration) of

the fluorinated gases ("F-gas") refrigerants. To date, zero heat-pump equipped dishwashers have arrived at these installations because of their negligible market share (0.01%), and their recent introduction on to the market (2011). Permanent magnet motors in dishwashers have been highlighted as important components for manual disassembly, since they often contain rare earth metals and copper. However, recent stakeholder feedback has indicated that newer permanent magnet motors no longer contain rare earths, and that copper has been replaced by aluminium, in the case of the latter owing to its lower costs and matching performance.

Consequently, against this background, ecodesign requirements for material efficiency and EoL management of household dishwashers have been proposed.

3.1.6. Summary of the revision

The review shows that further improvement potential for the energy efficiency of household dishwashers is possible and that resource efficiency requirements are important. The review study made a number of recommendations on ecodesign and energy label requirements that could be introduced or modified for dishwashers. These were based on the technical, market and economic analysis that was carried out. The European Commission has used these recommendations, together with the most recent data available from industry, as the basis for the proposed revision of Ecodesign and EU Energy Label requirements.

These aspects can be summarised as follows:

- Energy label classes: some dishwasher models already exceed the current EU Energy Label class A+++, especially those appliances with a higher rated capacity and which are equipped with heat pumps. An update of the energy labelling classes should provide a continuing incentive for manufacturers to carry on improving their appliances.
- Water consumption: the water consumption of household dishwashers per cycle and place setting is closely related to energy consumption, and both have been reduced significantly in the past few years. On the other hand, the consumer survey shows that a large share of households still usually pre-rinse each item, or at least pots, pans and casseroles under the tap which consumes additional water (and energy, if hot water is used).
- Use of the standard programme: for household dishwashers, only 19% of consumers use the standard ("Eco") cleaning programme that is prescribed for testing the appliance's energy performance. The normal/regular programmes are used more often (39% altogether) and consume more energy and water than the standard programme. It should be noted, however, that since the introduction of an obligation in 2012 to clearly mark the standard (Eco) programme on the machine, and set it as the default option, its use has increased. The increased use of the standard (Eco) programme among consumers underlies the continued selection of this programme for measurement purposes. Moreover, certain aspects of the standard are currently under revision so as to better reflect the real-life use of the dishwashers.
- Programme duration: the standard (Eco) cleaning programme, whose energy consumption value is displayed on the EU Energy Label and thus influences the purchase decisions of consumers, is designed and configured to improve energy efficiency. However, lower standard (Eco) programme energy consumption values are often achieved via firstly reducing the cleaning temperature and secondly prolonging the programme duration (characteristics that, according to the so-called "Sinner's Circle" principle, consumers find inconvenient). The 2015 user survey indicates that most consumers are willing to accept a maximum of 2-3 hours, whereas there is a reluctance to accept a total cleaning/ drying cycle duration of more than 3 hours. However, the use of the standard (Eco) programme has recently increased even though its duration has stabilised at around 3.5 hours.
- Technical innovation: the results from the review study show that additional energy savings could be achieved by implementing further technical improvement design options, such as fans,

automatic door opening, improved sensors, heat exchangers and consumer feedback mechanisms. These options barely influence the life cycle cost. The use of a heat pump increases the life cycle cost and does not obtain the energy saving results to the extent that would be expected from the increase in the energy efficiency performance of the standard (Eco) programme. This is due to the fact that, in real-life, other programmes are preferentially used, in which the heat pump is responsible for negligible, or very low additional emergy savings.

- Resource efficiency: there are statistical indications that the proportion of household dishwashers that have to be replaced earlier than the expected average lifetime has oncreased, especially within the first 5 years. Another contributing factor may be potential misuse of appliances by consumers.

This review study makes a number of recommendations on the Ecodesign and EU Energy Label requirements that could be introduced or modified for dishwashers. These were based on the technical, market and economic analysis that was carried out. The Commission has used these recommendations, together with the most recent data available from industry, as the basis for the proposed revision of Ecodesign and EU Energy Label requirements. These revisions aim to address the market failures that have led to some utilisation of sub-optimal design features by manufacturers, and a lower than expected use by some consumers of dishwasher programmes which contain improved environmental performance feautres, The revised requirements aim to:

- Realise the potential for cost-effective improvements to the energy efficiency of dishwashers;
- Reduce the use-phase energy consumption and emissions associated with dishwashers, thus reducing the overall effect that these products have on the environment;
- Realise the potential for increased resource efficiency, via requirements that facilitate repair (e.g. provisions and design for easy repair)
- Realise the potential for increased resource efficiency via requirements that facilitate recycling and depollution at the appliance EoL (e.g. design for dismantling, for the prupose of depollution, recovery and recycling)

3.2. Policy scenarios

Based on the results of the review study, the goal of the current revision is to see if technical design options, based on Ecodesign (ED) and Energy Label (EL) requirements can help to realise the saving potentials of more efficient technologies, and thereby increase the use of energy-efficient cleaning programmes. In this sense, for household dishwashers, the following policy scenarios were investigated during the review study.

Table 4: Comparison of possible policy scenarios for household dishwashers

Scenario	Sub-scenario	Comments
0. Business as usual	BAU	No change in the current situation for dishwashers, and no further policy tools implemented. This is a not realistic option, given the revised 2017 EU Energy Label regulation requirements, but it serves as a reference scenario.
1. Stricter Ecodesign-only minimum energy performance requirements and removal of the EU Energy Label	Only Ecodesign	Increase in the minimum threshold for energy efficiency and removal of the EU Energy Label. From 2020, EEI < 56, to comply with Ecodesign ,minimum performance requirements,
2. EU Energy Label classes revisions	2a = HP-DWs in class B	A strict EU Energy Label revision where it is likely that solely appliances with certain particular technologies (e.g. incorporation of a

Scenario	Sub-scenario	Comments
		heat pump) will be placed in the best EU Energy Label classes. This could cause the market to split according to different technologies, to reach a specific distribution of Energy Label classes regarding products, e.g. in the highest label classes, only heat pump-equipped machines would be present. Also, in this sub-scenario, minimum energy performance requirements would not be updated as they are already judged to be sufficiently ambitious
	2b – Ecoprogramme time limitation	The energy classes are revised to an A-G scale and an additional requirement on the maximum duration of the Eco-programme is put in place. Distribution of the energy efficient classes are stricter than 2c
	2c. – Ecoprogramme time limitation.	The energy classes are revised to an A-G scale and an additional requirement on the maximum duration of the Eco-programme is put in place. This requirement keeps the duration of the Eco-programme under the limits accepted by consumers. This could give incentivise the market to develop more energy-efficient products within real-life consumer acceptability boundaries/ constraints.
3. Additional measurement of the automatic programme		Applied to scenario BAU and 2c with an optimized and more efficient automatic programme, i.e. as efficient as the Eco programme, in order to estimate the most optimistic scenario.
4. Increasing durability	4.a Manufacturing more robust machines	The scenarios on durability/reparability model possible extensions of the average time a product remains in the EU stock (in-service), either by: (4a) manufacturing more robust machines (i.e. increasing the technical product lifetime from 12.5 years to 15 years),
	4.b Increasing repair	or (4b) by increasing the number of machines that are repaired (i.e. from 38% to 58%)
	4.c Iincreasing reuse	or (4c) by increasing the levels reused (from 8% to 18%).

3.2.1. Scenario 0: Business as Usual (BAU)

The definition of the Business as Usual (BAU) scenario for dishwashers is based on the assumption that no additional regulation is implemented. This does not mean that without further regulation the sector will not improve the energy and/or resource efficiency of its products. However, given the historical development of energy consumption in dishwashers over time (q.v. Figure 5), it can be assumed that a "plateau" will be reached. Since improving energy efficiency might come at a higher cost, it is expected that it would not be achieved as quickly as in the other scenarios. Thus, in this scenario it is assumed that there are few additional energy efficiency improvements. As the EU Energy Label would lose its potential for differentiating dishwashers, manufacturers would have little incentive to go beyond the current energy label class A+++, except for advertising claims (e.g. 20% more efficient than the A+++ class). However, these claims would be difficult to verify, as they would not be bound by EU/ Member State legal rules. A gradual shift for dishwasher products to solely populate the A+++ class could be expected.

3.2.2. Scenario 1: Stricter minimum energy performance requirements via Ecodesign, and removal of the EU Energy Label

In this scenario, the EU Energy Label is removed and Ecodesign stricter minimum energy efficiency requirements are implemented by only allowing machines with EEI< 56 on the market as from 2020 (i.e. appliances with energy efficiency class A+ and lower would no longer be allowed on the market).

However, manufacturers would not be strongly motivated to improve dishwashers beyond mandatory requirements since there would be no competition to reach higher energy efficiency classes via the EU Energy Label. Manufacturers could instead focus more on lowering costs, or looking further into other non-energy related parameters such as better basket design, durability, reparability, internet connections, etc. Some manufacturers would continue to improve/invest in their products and communicate their improved energy efficiency to consumers.

In such a scenario it is important to consider that the EU Energy Label also currently displays environmental and functional information to consumers, such as water consumption, drying efficiency, noise and the number of place settings. If the EU Energy Label were removed it is not certain in which form and how this information should be otherwise be shared with consumers.

3.2.3. Scenario 2a, 2b and 2c: Revised labelling classes

Energy labelling is a mechanism to help consumers to make an informed decision, especially regarding the energy consumption of appliances. It serves to differentiate products and identify machines with the best energy performance. In these scenarios, the label class differentiation is created with a full scale of seven energy classes that range from A to G. No other ecodesign requirements on energy consumption are put forward, because dishwashers have already reached a high level of efficiency, ever since the introduction of the first energy label in 1997 (see Figure 5 to Figure 8). The three sub-scenarios 2a, 2b and 2c differ mainly regarding the strictness of the requirements for the label classes.

The label class thresholds for the three sub-scenarios are shown in Table 5.

Table 5: Current energy label class distribution, and revised label class distributions for scenarios 2a, 2b and 2c.

Since 2011*			Revision							
				Scenario 2a		Scenario 2b		Scenario 2c	
Label class	EEI min	EEI max	Label class	EEI min	EEI max	EEI min	EEI max	EEI min	EEI max
A+++		50	A		34		36		38
A++	50	56	B	34	38	36	40	38	41
A+	56	63	C	38	43	40	44	41	45
A	63	71	D	43	48	44	48	45	49
B	71	80	E	48	53	48	53	49	54
C	80	90	F	53	58	53	58	54	58
D	90		G	58		58		58	

* The classes marked in red are not allowed because of minimum ecodesign requirements that have already been implemented. Note that countertop machines are still allowed with an EEI of < 71.

To better understand the implications of the different thresholds it is important to know the EEIs of the best available appliances currently on the market, which are shown in Table 6.

Table 6: Annual energy consumption and EEI of best available dishwashers on the market in second quarter of 2017

	No. of place settings	Annual energy consumption	EEI
A+++ -30% (heat pump dishwasher)	13 ps	154 kWh/a	35*
A+++ -20% (best DW without heat pump)	14 ps	189 kWh/a	40
A+++ -10%	13 ps	211 kWh/a	45

* source: https://www.vzug.com/ch/en/controller/EuDatasheetPdfController/V-ZUG-GS60SLWPdic-4104600012.pdf?product=4104600012

At the time of writing (October 2017), there were no known machines with an EEI < 40 which did not employ heat pump technologies. This means that, initially, class A would be completely empty for scenarios 2b and 2c (with the exception of heat pump appliances). These scenarios would also represent the market situation if a limitation on the time programme duration of the Eco-programme were introduced. As can be seen, Scenario 2b is stricter than scenario 2c. In both scenarios (2b and 2c) manufacturers would be motivated to develop machines that would achieve higher energy label classes (i.e. classes A to C), since there are already dishwashers on the market that have achieved the proposed class C (currently A+++ -10%) and the proposed class B (currently A+++ -20%). The proposed EEI limits for classes A and B are positioned in order to leave room for further innovation. Dishwashers that currently reach A+++ would – after reclassification - be positioned in the new proposed classes C-D, The current A++ class appliances would be reclassified under class E, and present A+ dishwashers would be reclassified as class F. Table-top dishwashers would fall into label class G. It should be noted that currently only 8% of the sales of all dishwashers are classified A+++ or higher (according to manufacturers' claims). The majority of dishwashers would therefore still be classified between classes D and F, thus leaving considerable room for improvement.

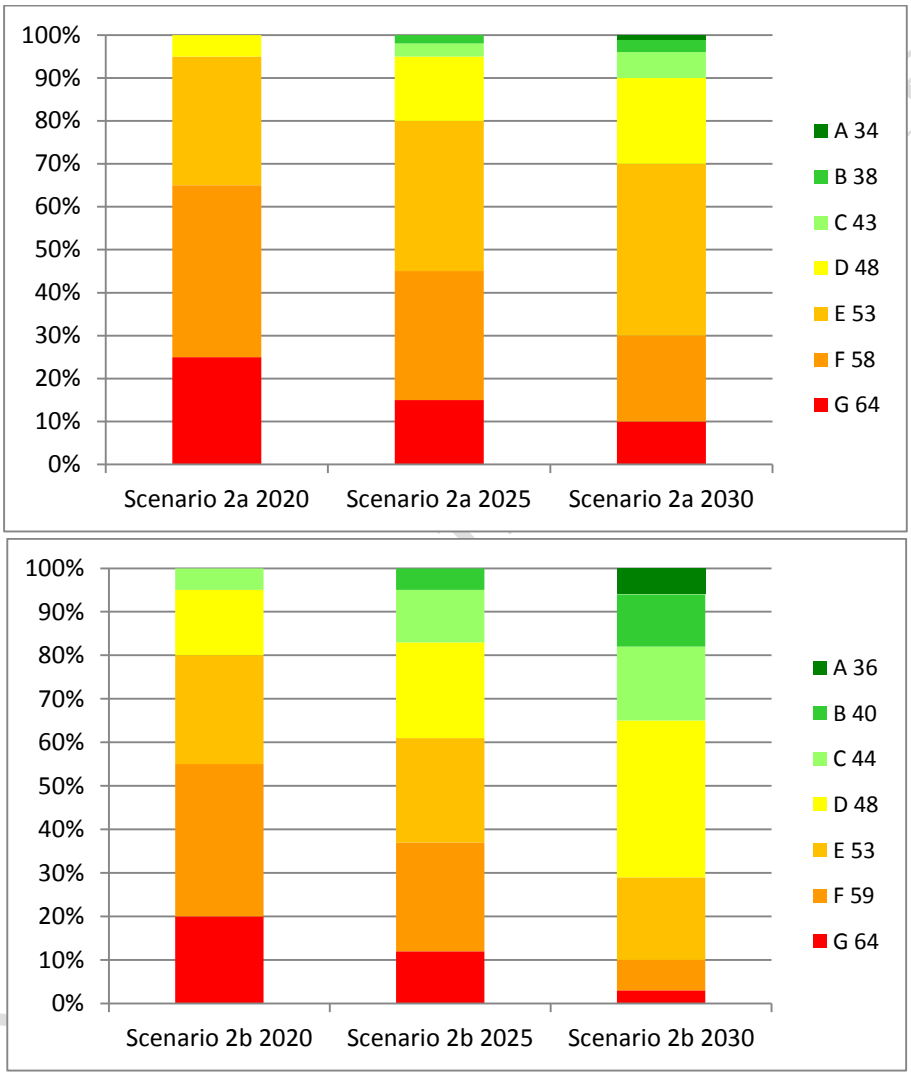
Both scenario 2b and scenario 2c would allow appliances equipped with a heat pump (i.e. EEI = 35) to be classified in energy class A from the beginning of the Energy Labelling revision, if no additional restrictions (e.g. on the duration of the Eco programme that discourages consumer use) were introduced. This might be in conflict with a proposal made in the revision of the energy label directive, which states that "*no products are expected to fall in energy class A at the moment of the introduction of the label*" (Regulation 2017/1369). However, it should be noted that the sales figures for appliances equipped with heat pumps are currently very low (around 0.01% of the total sales), and currently have a purchase price of in excess of 4,000 Euros.

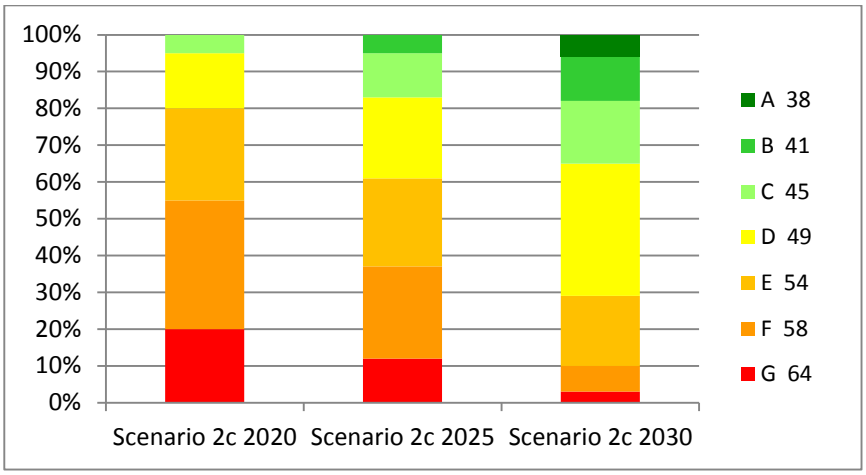
Scenario 2a shows an energy label class revision in which the current heat pump-equipped dishwasher products would fall into class B, which would leave class A empty. However, given that this is the second revision of the energy label for dishwashers, it is expected that additional energy improvements would be more difficult to acheve, since further technological progress may be slow. Hence, it may be justified to argue to maintain solely label class A empty, rather than keeping both label classes A and B empty.

Moreover, keeping energy class B empty at the start of this revision would mean that a very low level of differentiation among the products would be achieved. Such a distribution of the different classes over the range of EEIs (taking into account the current ecodesign measures) would mean that the best non-heat pump model (currently A+++ -20%, EEI = 40) would be placed in class C on revision. Most of the other models would be placed in classes E and F. Under such circumstances, the market might split into heat pump-equipped machines, which are more complex and expensive, and (often cheaper) dishwashers without this technology. It is also important to mention that heat pump-equipped dishwashers do not provide expected savings in real life. Producers of dishwashers not containing heat pumps would have little incentive to improve the energy efficiency of their products, since the products would remain in the

lower or middle EU Energy Label classes. Instead, they might prefer to compete in terms of cost reduction (leading to reduced purchase prices) or other developments not linked to energy efficiency (e.g. interior and exterior design). Finally, it should be noted that dishwashers with a heat pump use more material and are more complex, which could lead to a higher rate of failue, with possible related repair difficulties.

Figure 20 shows the forecast for the evolution of the sales distribution in terms of EU Energy Label efficiency classes between 2020-2030 for each of the scenarios 2a, 2b and 2c. It should be mentioned that it is difficult to estimate future sales distributions, and that the actual distribution compared to the predicted outcome has a large influence on the resulting energy savings and other impacts.





In the legend, the label classes are accompanied by their maximum EEI value.

Figure 11: Estimated sales distribution for scenarios 2a, 2b and 2c

Given the current knowledge basis for scenario 2a, it would be very difficult, if not impossible, for dishwashers to reach a high EU Energy Label class unless they were equipped with an expensive heat pump. Morever, the current high purchase price of dishwashers containing heat pumps makes a broad uptake of these types of products unlikely. It should also be mentioned that if there were a massive switch to heat pump-equipped dishwashers, then other environmental impacts could increase.

Another issue to consider is that almost all dishwashers without heat pumps would fall into the energy efficiency classes D to G, which might lead to a consumer perception that most of the machines were of lower quality. If this became the case, it might have the knowck-on effect of decreasing the market penetration rate of dishwashers overall, in favour of hand dishwashing. This could therefore lead to the adverse effect that, overall, more energy and water would be consumed as a result of the revision of the energy label. A switch to hand washing or a lower dishwasher market penetration rate is not included in the model, but would reduce potential energy and water savings..

Note that a similar market change happened with tumble dryers (i.e. a switch to heat pump equipped appliances). It should be mentioned, however, that the energy savings attributed to a heat pump in tumble dryers are much more significant than those used in dishwashers. In addition, introducing a heat pump in tumble dryers is less complex than for dishwashers, as in the latter there are more space restrictions.

It is possible that another technology capable of competing with the heat pump in terms of energy efficiency might be developed, but there is currently no indication of this. Moreover, today most manufacturers are hesitant to use heat pumps in dishwashers, thus making it a mainstream technology, since they perceive the heat pump equipped-dishwashers to be more of a "front-runner technology" with low sales potential. Additionally, it should again be mentioned that heat pump equipped dishwashers perform extremely well in the standard (Eco) programme, but real life associated energy savings are lower, and are similar to other more "mainstream" technologies that have a lower EEI value.

3.2.4. Scenario 3: Measurement of "Eco" and automatic programmes under two measurement conditions

This scenario assumes that besides the standard (Eco) programme, the automatic programme would also be measured for compliance purposes regarding the EU Energy Label and Ecodesign requirements. The automatic programme would be measured under two usage conditions (e.g. full load and full soil, and full load and half soil). Under such testing conditions, however, it is assumed that the automatic programme

would be optimised with regard to the two defined usage conditions, meaning that the energy consumption of future automatic programmes would then be lower than that of current automatic programmes, whereas the programme duration would be longer as today. All in all, the automatic programme would be similar to the current Eco programme.

Two possible consequences of the above assumptions might be that: (1) the automatic programme becomes less attractive to consumers (owing to its longer programme duration); and (2) manufacturers could introduce additional programmes, in order to offer more attractive (i.e. shorter) programmes to consumers. It should be noted that the model does not consider a possible shift from the automatic to other programmes.

3.2.5. Scenario 4: Increasing durability

A complex question which needs to be addressed is that of whether or not it is better to replace an older dishwasher earlier than functionally necessary by a more energy efficient dishwasher.. This question can also be postulated as "whether an extension of product lifetime brings benefits". The assessment of the potential net environmental benefits when the durability (with or without repair) is improved should be assessed in a scenario that compares the single life of a longer-lasting dishwasher to the use of two machines over the same period of time, but where the second machine (which is replacing the first product) is a more energy-efficient model. Tecchio et al 2016 have estimated that with the use of current-technology stock and labelling a replacement dishwasher has to be at least 15% more efficient to serve as an 'efficient' replacement. In this study, preliminary estimations are made which could be further refined in the actual impact assessment.

The repair of performance failures in dishwashers will have an impact on the average time a product remains in the European stock. The BAU scenario estimated that old in-service dishwashers would be replaced by new ones after an average of 12.5 years on the market (in-service time), and that approximately 70% of machines would fail via some fault(s) during their lifetime. An appliance that is designed for easy repair is expected to reduce the share of appliances that are discarded/ sold on before they reach the average service lifetime of 12.5 years. This scenario considers that 38% of dishwashers are repaired once in their lifetime, and the 8% of dishwashers that have been discarded – but which are still in a usable condition – are modelled instead as being reused.

In the scenarios on durability/reparability, possible extensions of the time an average product remains in the stock (in-service) are modelled. The assumptions are that this is achieved either by manufacturing more robust machines (i.e. increasing the technical product lifetime, scenario 4a) or by increasing the number of machines that are repaired (scenario 4b) or reused (scenario 4c). The increase in the amount of machines that can be repaired is due to measures that either increase both the ease and technical feasibility of a repair and/or decrease the cost of a repair. The extension of the in-service time of a dishwasher will have an impact on sales forecasts (especially replacement sales), and will also impact consumer expenditure, energy and water savings, and other related parameters.

In the preliminary investigation of the possible effects of increased product longevity, durability and reparability, only a first approximation is explored of the potential estimated impacts on electricity consumption, and on manufacturing, retail, repair/ maintenance and related turnover and employment. It should be noted that the influence of these scenarios on the use of resources has not been analysed. More durable products are expected to save resources, in particular those associated with the life cycle phases of production and raw material extraction. However, there are also environmental impacts associated with the manufacture and distribution of spare parts, and the provsion of repair services. Only the impact on electricity consumption and effects on manufacturer and retail jobs are shown in this document. The influence of these scenarios on the use of resources has not been studied here. Intuitively, one could think that more durable products would save resources, but this has to be further investigated.

Table 7: Parameters changed in comparison to the BAU scenario for each of the scenarios 4a, 4b and 4c

Scenario	Measure	Technical lifetime (years)	% of repairs	% reused machines without failure	Average in-service time (years)
BAU	-	12.5	38%	8%	12.28
4a. Durability	Increase in the technical lifetime	15	38%	8%	14.89
4b. Reparability	Increase % of repairs	12.5	58%	8%	13.43
4c. Reuse	Increase % of reused machines without failure	12.5	38%	18%	12.31

3.3. Environmental significance of the proposed policy scenarios

A formal Impact Assessment (IA) will be conducted, commencing after the product-specific Consultation Forum (CF). The following figures come from the review study and are indicative until the formal IA.

Possible impacts on consumption of electricity and water, and consumer expenditure

The different scenarios are estimated to have varying impacts on the evolution of resource consumption (energy and water) in the EU28. For all scenarios, the overall energy and water consumption related to the 'population' of dishwashers in the EU28 is expected to increase between 2015 and 2030, even though individual machine consumption will decrease over time. This is due to the expected increase of the dishwasher stock on the EU28 market, because of the combined effect of the growth in number of households and the increase of ownership rate (i.e., this is an unsaturated product market, with many potential new product owners who have yet to buy their first dishwasher).

The expected electricity and water consumption of the **scenarios 1 and 2** are displayed in **Error! Reference source not found.** and **Error! Reference source not found.**, respectively. **Error! Reference source not found.** shows that the maximum electricity savings are expected for scenario 2c with an annual energy saving of 2.0 TWh/year by the year 2030. This is a saving of about 5% of dishwasher energy consumption compared to the BAU scenario estimated for the year 2030. As a comparison, 2.0 TWh is 0.3% of the total electricity consumption of private households in the EU28 in 2014 (67.5 Megatonnes of oil equivalent [Mtoe], i.e., c. 785 GWh). Note that scenario 2a is not the most efficient scanario, even though intuitively one would expect this, since it proposes the strictest requirements. This counter-intuitive observation is due to the assumptions made in the distribution of the appliances (see Figure 11), which are split into two large groups over the different label classes (highly efficient machines, compared to the second population of machines which fall into the lower energy efficiency classes).

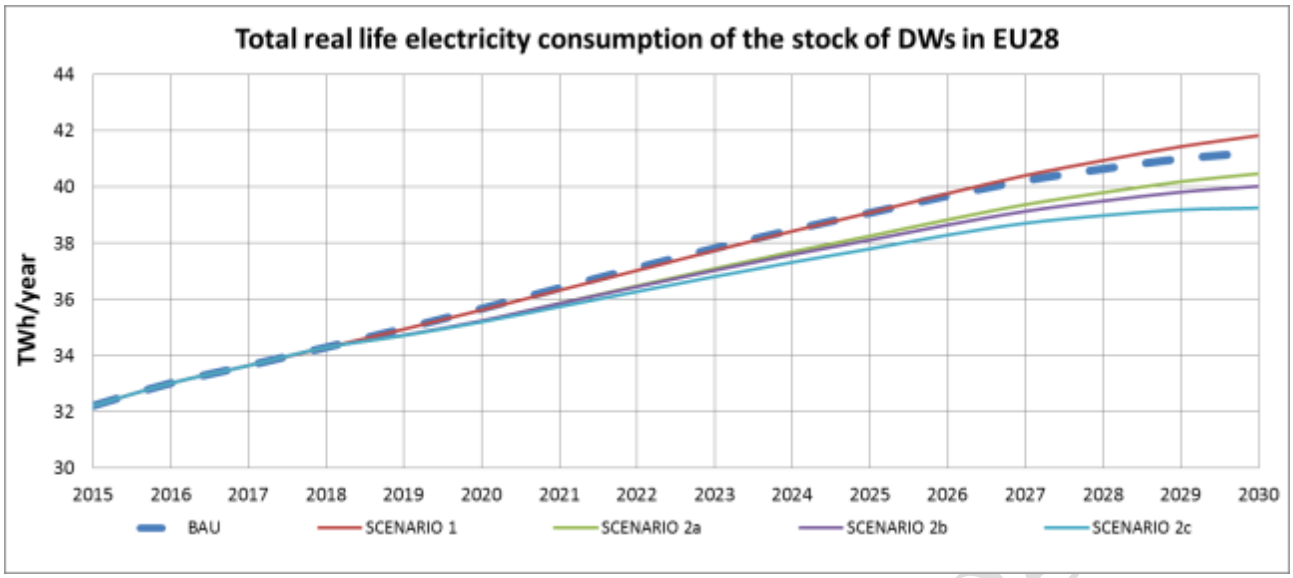


Figure 12: **Estimated annual total electricity consumption for the stock of dishwasher in EU28 under the assumptions of scenarios 1 and 2 compared to BAU scenario**

The energy savings of **scenario 3** have been roughly estimated, considering also the assumptions performed for scenario 2c. The same assumptions are utilised as in scenario 2c, with the sole difference being that in 2030 it is assumed instead that the automatic programme consumes the same amount of electricity and water as the standard (Eco) programme. This changed assumption means that in the model,, the correction factors would change that convert the Eco programme energy consumption (on which the energy label is based) to the realistic use pattern energy consumption..Note that this would be the most optimistic scenario, since the effect that this measure could have on user behaviour and the programme preferences is not considered. Under these assumptions, an additional 0.5 TWh/year could be saved by the year 2030. Note that the costs of additional test burdens have not been estimated.

The maximum water savings of 22 million m^3 per year are expected in 2030 for scenario 2b (**Error! Reference source not found.**). Thisamount is around 5% of the water consumption expected in the year 2030 in the BAU scenario for the overall stock of dishwashers in the EU28.

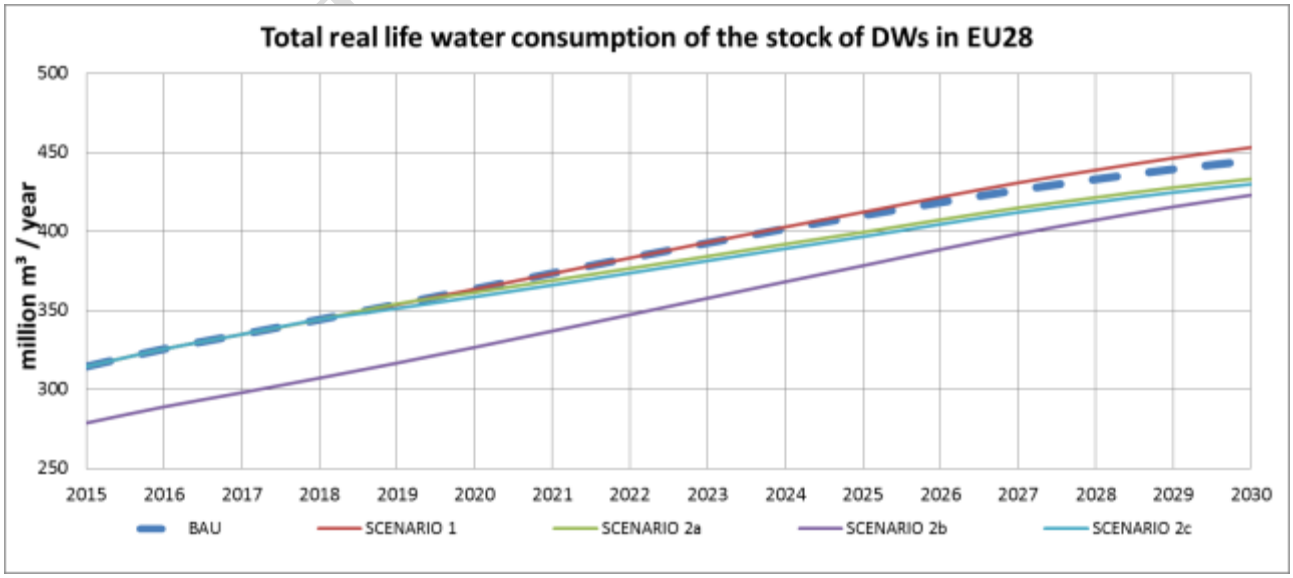


Figure 13: **Estimated annual total water consumption for the stock of dishwashers in EU28 under the assumptions of scenarios 1 and 2 compared to BAU**

With regard to total consumer expenditure, scenarios 1 and 2 result in a decrease of the total EU28 consumer expenditure in comparison with the BAU scenario, as shown in **Error! Reference source not found.**. Consumer expenditure takes energy, water, repair and maintenance and auxiliaries costs into account. Repair and maintenance, and auxiliaries costs (detergents, regeneration salt and additives) are the same for all scenarios, but purchase price, energy and water costs change. A maximum saving of around 0.72 billion euro$_{2015}$ per year is estimated for the year 2030 in scenario 2c.

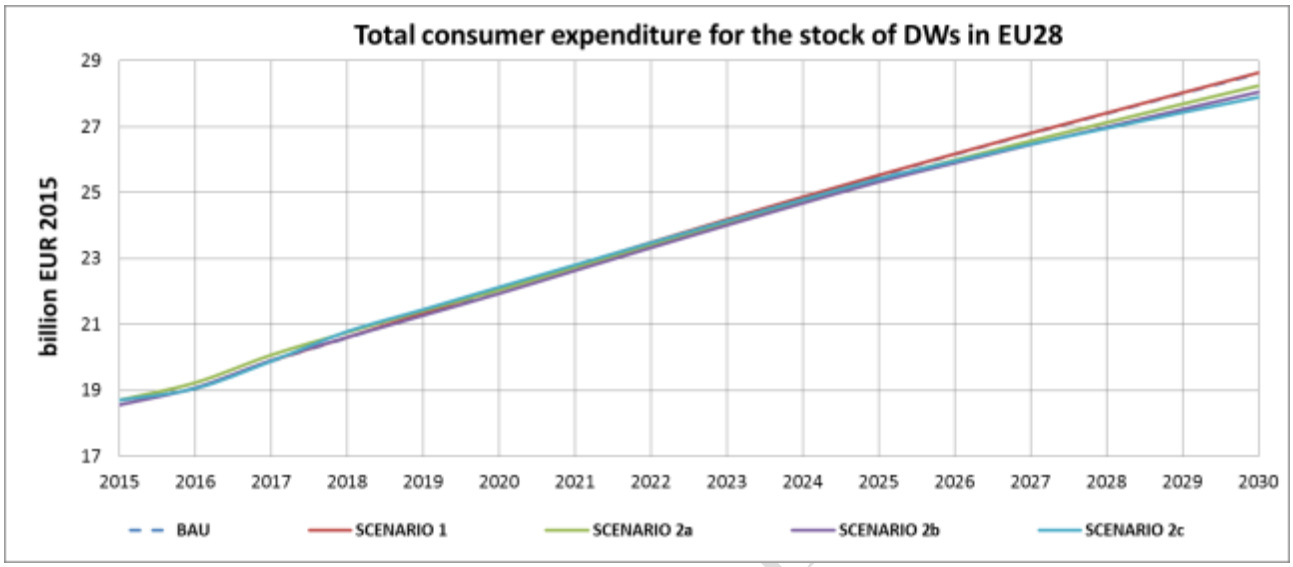


Figure 14: **Estimated consumer expenditure for the dishwasher stock in EU28 compared to the BAU scenario**

Possible Impacts on turnover/ employment and labour markets (Scarios 4a, 4b and 4c)

A prolongation of the service lifetime of dishwashers may have different impacts on the economic activities of the various sectors involved, e.g., product manufacturers, product retailers, maintenance and repair sectors, rental/ leasing, and End of Life resource/ recovery/ waste management enterprises.

Deloitte (2016), on behalf of the European Commission, is carrying out an ongoing study, addressing the socioeconomic effects of increased reparability. Among other aspects, variations in turnover, and knock-on effects regarding employment and labour markets have been considered. The authors have concluded to date that there would be expected marginal gains in the total aggregated impacts on the turnover of the relevant sectors affected (manufacturing, retailing of new and old products, repair and waste treatment), and that where manufacturers do experience losses, these would be more likely to occur outside the EU.

Another recent study (Montalvo et al, 2016), commissioned by the European Parliament's Committee on Internal Market and Consumer Protection (IMCO), highlighted that some benefits should accrue via longer-lifetime products in the EU due to changes in EU value-added economic benefits, the related balance of trade between the EU and extra-EU, and changes in labour markets. This study pointed out that:

- European jobs are likely to be created if businesses increase their added-value within the territory of the EU, especially in non-tradeable services that need to be provided locally. The job creation estimations vary between Member States.
- Increasing the longevity of products may have an influence on the balance of trade, because fewer imports would be required to maintain the current level of product stocks within the European market.
- Many jobs created would be linked to employment in maintenance and repair activities. These types of jobs have tended to decrease in the EU in recent decades partly owing to globalisation, coupled with

relatively high average EU wages, and few fiscal incentives (at Member State level) to encourage maintenance and repair.

Negative effects regarding extending the lifetime of products could be expected to occur in the manufacturing sector**,** regarding some losses in sales and/or market share. The drop in product manufacturing is expected to be partially counterbalanced by the increased production of spare parts and the increase of repair services for those manufacturers which provide such services. However, the overall effect on the turnover of manufacturers is expected to be slightly negative.

It is important to note that the above effects may have positive future effects on the EU/ outside-EU balance of trade, depending upon the reactions of manufacturers, in-house repairs that these manufacturers may offer, and – in parallel - the reaction of the EU-based independent repair sector. Evidence which supports this statement has been found for washing machines. It is assumed that for dishwasher sector the same conclusions can be applied. The above mentioned evidence consists of the following:

1. More than half of the value (54%) of the EU's annual sales of new washing machines occurs as a result of products that are imported from outside of the EU(Deloitte 2016). Hence, in parallel, any manufacturing job losses are projected to occur proportionately more outside of the EU than within the EU's borders.

2. There is a relatively higher percentage of the total imported mass of washing machines (62%) made outside the EU, but sold on the EU markets. This can be extrapolated to signify that a higher proportion of lower-value washing machines are produced outside of the EU (Deloitte 2016), when compared with the above statistic.

3. Available (slightly dated) information on the ownership of retailer businesses selling washing machines and washer dryers on the EU market shows that c.80% are in EU ownership (European Commission 2008a). Owing to the increased lifetime of new products within scope, these businesses may also face a reduction in turnover. However, this drop may be partially counterbalanced by the increased sales of spare parts and repair services.

The potential measures aimed at extending the lifetime for products may result in benefits especially to those companies (both manufactures and retailers), which are able to adapt, and to provide a variety of efficient after-sales services, e.g., an increase in the provision and consumption of possibly intra-EU goods (e.g., product components) and services related to repair and maintenance. This may also lead to a shift of jobs from manufacturing or product retail per se, towards offering a provision of services, including service packages (including maintenance and repair), or service-based contracts (e.g., on a pay-per-use basis, rather than product ownership), product leasing, product rental, etc. It is important to note that EU-based businesses have the commercial advantage of being geographically much closer to their customers in EU markets, for this potential re-orientation of their after-sales services, since distance – and time - to the client are key cost factors.

Another factor to take into account is that the priorities of the Research & Development sector/ component of companies may be expected to partly shift, from reducing costs in production to also placing an increasing emphasis on designing more durable and reparable products. Such R&D shifts would assist the market penetration of the above potentially redefined commercial strategy.

Regarding the energy consumption of dishwashers during the use phase, there are no relevant changes compared to the BAU scenario for Scenarios 4a, 4b and 4c, as shown in Figure 15

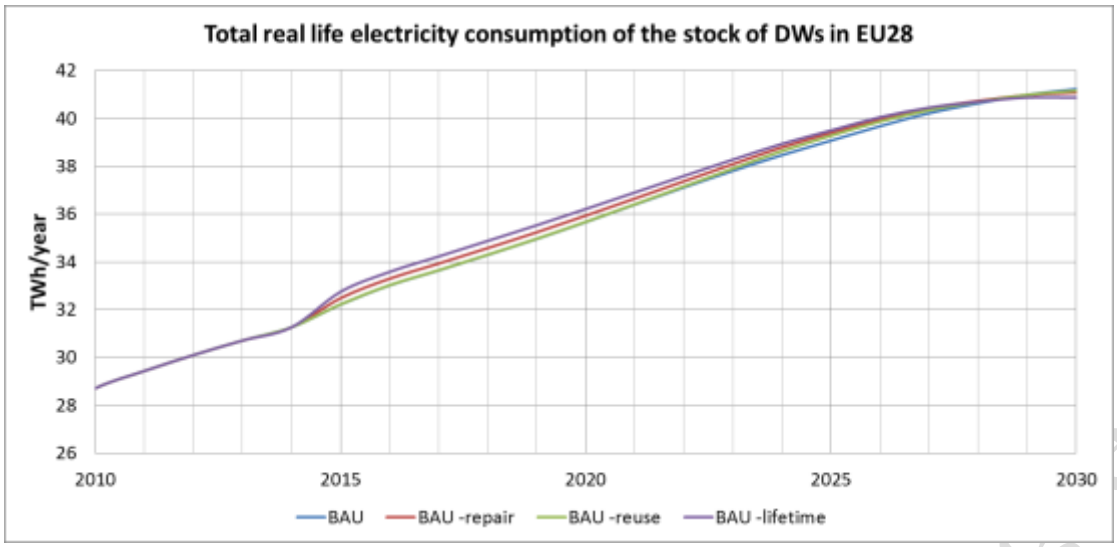


Figure 15: **Estimated enegy consumption in EU 28 under the actual use conditions of the BAU scenario with scenario 4a, 4b and 4c**

4. PROPOSED DRAFT MEASURES

Based on the results of the review study, the following Ecodesign and EU Energy Label measures are proposed for household dishwashers.

4.1. Scope and exclusions

The same **scope** of the current regulations will be maintained in the revised regulations.

Professional dishwashers, which have distinct characteristics and uses, will continue to be exempted from the scope of the revised ecodesign and energy label regulations for household dishwashers. They are subject to separate regulatory work (e.g., Commission implementing decision M/539 of 11.12.2015, on a standardisation request to the European Committee for Standardisation as regards non-household washing machines, dryers and dishwashers). This distinction between household and professional appliances is further clarified in the proposed revised Ecodesign and EU Energy Labelling regulations by referring to the Low Voltage Directive 2014/35/EU for household appliances.

4.2. Ecodesign requirements

The calculation methods of the performance parameters (Energy Efficiency Index, Cleaning efficiency Index, Drying efficiency Index, Water consumption) are aligned in the draft proposals for the revised Ecodesign and the EU Energy Label regulations.

4.2.1. Energy consumption

4.2.1.1. Calculation of the Energy Efficiency Index (EEI)

It is proposed to maintain the calculation of the EEI value similar to that of the current formulation. One difference is that the 'left-on' and 'left-off' modes are taken out of the formula. This allows for simplification.

To classify an appliance, the Energy Efficiency Index (EEI) is calculated according to equation 4-1:

$$EEI = \frac{AE_C}{SAE_C} \times 100$$

Equation 4-1

where: AE_C = annual energy consumption of the household dishwasher

SAE_C = standard annual energy consumption of the household dishwasher

Instead of defining the energy consumption **per year**, it is possible to declare and display the energy consumption **per cycle**.

Since January 2013, according to the second tier of the Regulation (EC) No1275/2008 for standby and off-mode, all household dishwashers have been required to be equipped with a power management system, with the household dishwasher reverting automatically to 'off-mode' after the end of the programme. Another equation, established in Regulation (EC) No 1059/2010, is currently applied for calculating the AE_C, taking into consideration the effective duration of the 'left-on mode'.

$$AE_C = E_t \times 280 + \frac{\{P_l \times T_l \times 280 + P_o \times [525600 - (T_t \times 280) - (T_l \times 280)]\}}{60 \times 1000}$$

Equation 4-2

Where

E_t = energy consumption for the standard cycle, in kWh and rounded to three decimal places

P_l = power in 'left-on mode' for the standard cleaning cycle, in W and rounded to two decimal places

P_o = power in 'off mode' for the standard cleaning cycle, in W and rounded to two decimal places

T_t = programme time for the standard cleaning cycle, in minutes and rounded to the nearest minute

T_l = measured time in 'left-on mode' for the standard cleaning cycle, in minutes and rounded to the nearest minute.

It is proposed to take the left-on mode and left-off mode out of the calculation of the annual energy consumption, since their contribution is estimated at around 2%, on average. Instead, maximum power consumption of the 'left-on mode' and maximum duration of the 'left-on mode', until the power management function applies, have been introduced. Therefore, it is proposed to simplify the formula to:

$$AE_C = E_t \times 280$$

The SAE_C is indicated in kWh/ year (it assumes 280 dishwasher cycles are utilised by consumers per year) and depends on the rated capacity and the width of the dishwasher. For dishwashers with a rated capacity of 10 ps or more and a width of more than 50 cm:

$$SAE_C = 7{,}0 \times ps + 378$$

Equation 4-3

For dishwashers with a rated capacity of 9 ps or less and a width of 50 cm or less:

$$SAE_C = 25{,}2 \times ps + 126$$

Equation 4-4

Note that it is proposed to continue to definr the energy consumption based on the standard (Eco) programme, which must be clearly indicated on the machines. No testing of additional programmes is proposed, for reasons of transparency, and to avoid imposing any additional testing burdens on manufacturers and Member States' market surveillance authorities. This is backed up by feddback which indicates that the 'Eco' programme is used more and more since its introduction on machines, and as the default programme. Note, however, that it is imposed on manufacturers that they must not use potentially misleading programme names, such as 'daily', 'normal', 'standard', etc. that might guide the

consumer away from using the recognised 'Eco' programme. This imposition is designed to avoid any such undermining of the energy-saving objectives intended via the use of the "Eco" programme.

It is not necessary to refer to the width of the appliances, since appliances with ps ≤ 9 are by definition of the slim-line or countertop type. Where ps ≥ 10, the dishwasher has a standard width of 60 cm.

4.2.1.2. Low power modes

Standby modes are regulated by the Standby Regulation (Commission Regulation (EC) No 1275/2008), and Commission Regulation (EU) No 801/2013 amending the Standby Regulation. Dishwasher appliances are covered by the vertical regulation on these low power modes, i.e., under the umbrella set up by the Standby Regulation. The only low power mode identified in dishwashers as not being described within the remit of the above-mentioned regulations is that of the 'delayed start' mode.

Considering these issues, it it is proposed to explicitly write into the revised dishwasher regulations the maximum requirements for energy consumption of the off-mode, left-on mode, network connectivity mode and any other mode before the machine starts its cleaning cycle (e.g. 'delayed start' mode). Additionally, it is proposed to switch any other low power mode to standby or off-mode after 20 minutes using a power management system.

4.2.1.3. Minimum energy efficiency requirements

Even though the latest requirement on energy efficiency came into force only in 2016, stricter minimum energy efficiency requirements are proposed to be set for household dishwashers. It should be taken into account that this is a second revision, and that the current energy efficiency thresholds are already set at what may be considered a high level. Technically, it would be possible to require that all household dishwashers with ps > 7 should have a minimum EEI value of 58. For table-top dishwashers, i.e. where the capacity is ps ≤ 7, a minimum EEI value requirements of 63 is proposed.

Note that in the review study the effect of setting stricter minimum ecodesign requirements at a threshold energy efficiency of EEI < 56 was investigated, without including the effect of the energy label.

4.2.2. Water consumption

Water consumption is closely related to energy consumption. Market data show a steady decline in water consumption over the past few years. Currently, household dishwashers use a low volume of water to perform a cleaning cycle. Further progress is still possible but will be more limited in future because of the minimum water flow needed to ensure the cleaning performance. Therefore, it is proposed to maintain an indication of water consumption on the Energy Label, to inform the consumer.

The annual water consumption (AW_C) is given by the water consumption of the standard cleaning cycle (W_t) and the usage frequency of 280 cycles per year:

$$AW_C = W_t \times 280 \qquad \textbf{Equation 4-5}$$

4.2.3. Cleaning and drying performance

The current requirements on the Cleaning Efficiency Index are proposed to be kept unchanged. The Drying Efficiency Index is proposed to be set at the same level for all dishwashers.

4.2.4. Resource efficiency requirements

Ressource efficiency requirements serve three main prurposes:

1. To ensure that the expected durability of appliances in design is met, and that the consumer is well informed of the lifetime support to expect for an appliance at the moment of purchase.
2. To support more efficient recycling, introducing requirements that help recyclers to comply better with the WEEE Directive (2012/19/EU), by providing information relevant for depollution, dismantling and sorting operations. This will result in higher quality output streams.
3. To support a level playing field in the market market for product repair, to the benefit of consumers. Some current aftermarket practices of manufacturers restrict or hinder the access to the products of the independent repair market, and these practicese increase the final cost of repair to consumers. It is proposed to introduce requirements that eliminate such practices.

These requirements are aligned with ecodesign requirements adopted so far, and expand them, underpinning the objectives of the Commission's Communication "Towards a circular economy: a zero waste programme for Europe" (2015), which aims at establishing a common and coherent EU framework to promote the circular economy.

Thorough discussions have taken place with the affected stakeholders, and it has been checked that the proposed requirements should result in small costs to manufacturers, whilst delivering cost reduction and improved efficiency for the recycling industry, and important benefits to consumers.

To this end, the resource efficiency Ecodesign proposed requirements are detailed and explained in the following sections.

4.2.4.1. Mandatory communication of a minimum list of instructions to users

This list of requirements aims to support durability of the appliance, making consumers aware of the maintenance activated that are necessary during the use phase of the dishwasher. A second objective of this measure is to avoid repair operations that may be due to poor maintenance by the user. In some Member States or points of sale, information may be added that complements or replaces the information in the booklet.

This requirement also includes the communication on the period for which, or date until which, the spare parts necessary for the use of the machine will be made available, and the maximum allowable delivery time of such parts to the consumer. The minimum availability of spare parts is set at 7 years from the manufacture of the product, and the maximum allowable spare parts delivery time is set at three weeks.

4.2.4.2. Mandatory marking of Annex VII WEEE (2012/19/EU) components that are not present in all appliances, and are not visible from the outside

The objective of the mandatory marking is to facilitate identification of the presence inside the appliance of Annex VII WEEE (2012/19/EU) components that need separate treatment. The marking shall be readable for operators in treatment/recycling, as well as for direct visual inspection and control for market surveillance purposes.

The marking of F-gases present shall be on the product back panel. The required capacitor marking shall be displayed on the capacitor itself. Both the F-gases and the capacitor markings shall be visually by eye from a distance of about 2m. Both sets of marking referred to must be indelible and durable for at least the average lifetime of the appliance. Standardisation bodies are to define the adequate material characteristics, size, shape, etc. for the purpose described.

4.2.4.3. Requirements on design for dismantling for the purpose of depollution, material recovery and recycling of the appliance

This requirement supports more efficient recycling, by introducing requirements that help recyclers better comply with the WEEE Directive (2012/19/EU), by providing information relevant for depollution, dismantling and sorting operations. This will result in higher quality output streams. It is proposed that

access to, and extraction of, the components of concern (WEEE Annex VII, 2012/19/EU) must not encounter fixings that require proprietary tools, or tools which are not commonly available..

4.2.4.4. Spare part availability horizon declaration

The consumer shall be informed at the time of product purchase of the lifetime support to expect for an appliance. Spare part supply (availability, cost, delivery) shall not hinder repair. OEMs - to different degrees - already stock some or all spare parts of their appliances, and make them available. Spare parts sales is normally a lucrative business, since spare part sale prices usually have a large profit margin.

Implementing this requirement should logically lead manufacturers to define a list of spare parts considered as necessary for the use of the appliance and therefore made available under this requirement.

The verification of declarations is technically/ legally only partial, since this requirement is targeted to the future, and cannot, by definition, be automatically fulfilled at the moment when the product is placed on the market. Only the presence of the declaration can be undertaken at the moment of inspection. The future-oriented fulfilment of the content of the declaration is not verified via the CE mark-related Ecodesign fulfilment mechanism.

4.2.4.5. Spare part maximum delivery time

This requirement completes the previous requirement. Spare parts warehouses shall not be located overseas in Member States where the product is marketed if this hinders the delivery of spare parts, i.e., the warehouse location must not jeopardise the consumer's choice to undertake the repair.

Three weeks is proposed as the maximum allowable delivery time, with the exemption of force majeur conditions. Spare parts are delivered in Europe within ten working days. Responsiveness to a spare part request can be checked on the spot by market surveillance authorities, via checking compliance with the full delivery time.

4.2.4.6. Access to Repair and Maintenance Information (RMI)

This requirement obliges manufacturers to provide unrestricted access to appliance repair and maintenance information to independent operators, in a manner which is non-discriminatory compared to the provision given or access granted to authorised retailers and repairers. Manufacturers may charge reasonable and proportionate fees for access to repair and maintenance information.

The objective of this requirement is twofold:

1) to promote design for reparability, and to ensure that lifetime is not shorter than that for which the product was designed. As such, this measure avoids unnecessary environmental impacts.

2) to strengthen open markets for repair. Independent repair services shall not be blocked from gaining access to the market via restrictive practices from OEM repair services. Similarly, spare parts availability shall not be utilised as a barrier to prevent or hinder swift and cost-efficient repairs. Repair periods and costs shall be optimised to a minimum for consumers, independent of the provider of the service. Some OEMs currently hinder access to the design and repair information and tools. The overall aim is to avoid captive and monopolistic markets, since such structures result in higher costs for consumers.

After-sales services are a competitive arena that may be seen by some OEMs as an option for differentiation between manufacturers. However, to allow a fair and transparent differentiation, basic rules are necessary, by means of minimum Ecodesign criteria that ensure market transparency.

Availability for professionals to obtain repair and maintenance information upon registration/ certification shall be ensured openly and at a reasonable fee[6].

For the purpose of this requirement, professionals whose professional experience is recognised in implementation of Directive 2005/36/EC on the recognition of professional qualification, Article 16, for an activity included in group 379 'Repair, assembly, and specialist installation of electrical equipment' of Annex IV, List I, shall be considered as repairers.

Enforceability and control mechanisms will have to be developed to ensure the application of these measures.

4.3. Energy labelling requirements

After the release of the Energy Label Framework Regulation 2017/1369, class A shall be left empty when the policy enters into force. As of October 2017, the most efficient appliance on the market is a heat pump equipped machine with an energy consumption for the 'Eco' cycle of 0.55 kWh/cycle (EEI = 35). This declaration is higher than the declaration reported for an earlier (2016) version of the same appliance (0.49 kWh/cycle, EEI = 29.3). Note that this heat pump appliance uses an extremely long programme time of 4 hours and 55 minutes. Using the 2017 declared value for this product, and if one is to respect the request to leave class A empty, this would result in a maximum EEI value (i.e., minimum performance threshold) of 34 to achieve Energy Label class A. If one uses approximetely 10% EEI differences to set the brackets of performance for consecutive EU Energy Label classes, this would result in the following EU Energy Label class distribution for dishwashers, under Scenario 2a:

Label class	**Scenario 2a**	
	EEI min	EEI max
A		34
B	34	38
C	38	43
D	43	48
E	48	53
F	53	58
G	58	

Note that this scenario has not been evaluated in the review study; however, section 3.2 of this report presents the estimations used. The review study used the previous 2016 performance declaration for the grading of the heat pump appliance. During the Impact Assessment study, a detailed investigation of the differenctial performance boundaries for the A-G EU Energy Label classes suggested above would need to

[6] A fee is not reasonable or proportionate if it discourages access by failing to take into account the extent to which the independent operator uses it.

be performed, whether or not this is proposed to be combined with possible stricter Ecodesign minimum requirements.

It is also proposed to indicate the programme duration of the standard (Eco) programme on the energy label. Explicitly displaying this information on dishwasher appliacnes should contribute to dissuading manufacturers from designing a standard programme with a very (exagerratedly) long programme duration, solely for reaons of obtaining a higher Energy Label class, but with higher risks that it is solely a "virtual" energy performance and related Energy Label class, and that in reality such a programme might not be used by consumers.

Regarding water consumption, the user survey of the review study showed that consumers prefer water use per cycle to be indicated instead of indicating water use values per year. Therefore, it is proposed to indicate the consumption of water on the Energy Label on the basis of per cycle instead of per year, and to also apply this same approach to indicate energy consumption on a 'per cycle" basis.

Additionally, it is proposed to display noise emissions on the EU Energy Label both as a digit (integer number of dB) and via noise classes, similar to the method adopted in the regulation for the labelling of tyres (Regulation (EU) No 1222/2009). Three noise classes' descriptors are proposed: 'very quiet', 'normal' and 'loud'.

Note that most small machines, i.e table-top machines with ps ≤ 8, would be classified in the loudest noise class. For the standard machines, there is sufficient variation to span the three noise classes, although the majority of the machines would fall in the middle "Normal"-ratedclass, i.e. between 38 dB(A) and 47 dB(A).

5. FORM OF IMPLEMENTING MEASURES

The implementing measure will take the form of a Regulation setting minimum Ecodesign requirements, directly applicable in all Member States.

The Ecodesign requirements relate to the energy efficiency of the products within the scope of the Regulation. In addition, there are Ecodesign requirements on the provision of supplementary product information, and information related to resource efficiency aspects.

6. IMPACT ASSESSMENT

A formal impact assessment pursuant to Article 15(4)(b) of Directive 2009/125/EC will be undertaken subsequent to the Consultation Forum. Several policy options will be considered to achieve required market transformation to fulfil the appropriate level of ambition. The impacts of the policy options for revised Ecodesign requirements, together with a revised Energy Label for household dishwashers will be assessed against the 'business as usual' scenario..

7. RELATIONSHIP WITH OTHER ECODESIGN MEASURES

7.1. European legislation

The following regulations are relevant to the energy and environmental aspects of household dishwashers placed on the EU market:

- Commission Regulation (EC) No 1275/2008 of 17 December 2008 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements

for standby and off mode, and networked standby, electric power consumption of electrical and electronic household and office equipment. Horizontal measures included in this Regulation as well as in Regulation (EU) No 801/2013 on networked standby have been considered in the drafting of these measures.

- Commission Regulation (EC) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors.
- Commission Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases (the so-called "F-Gases Regulation") and repealing Regulation (EC) No 842/2006

(1) Directive 2012/19/EU of 4 July 2012 on waste electrical and electronic equipment (WEEE). Some of the resource-efficiency requirements in this proposed measure are aligned with the provisions of the 2012 WEEE Directive (i.e. Information requirements for refrigeration gases or requirements for dismantling for the purpose of avoiding pollution, and for material recovery and recycling of the household dishwasher).

- Directive 2011/65/EU of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS), as amended. In addition, Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), as amended, and Regulation (EC) 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures (CLP). These aforementioned measures are all relevant to household dishwashers since this product group may contain restricted substances, or substances of very high concern in any of the components used..

7.2. International legislation

International legislation and standards have been thoroughly analysed in the review study. Apart from the international standard on the performance of household dishwashers (IEC 60436 'Electric dishwashers for household use – Methods for measuring the performance'), no other international standard or legislation is directly affected by the revisions of the EU Ecodesign and Energy Label regulations for household dishwashers.

8. MEASUREMENTS AND CALCULATIONS

Measurements and calculations of the relevant product parameters must, when available, be performed using harmonised standards established in accordance with Article 10 of Directive 2009/125/EC, the reference numbers of which are required to be published in the Official Journal of the European Union. Altenratively, other reliable, accurate and reproducible methods may be used, as long as they take into account the generally-recognised state-of-the-art of related techniques pertinent to the product group concerned, and that they produce results deemed to be of low uncertainty.

Proposed requirements for calculation and measurement methods are specified in Annex II to the proposed Ecodesign measure and in Annex IX of the Energy Labelling measure.

A revision of the harmonised standard is currently under development to better reflect real-life consumer behaviour in the use of dishwashers. The main proposed changes are:

- a combined cleaning and drying method
- inclusion of new dishwasher load items (e.g. plastic items and pots and pans are included)

- utiliisation of a new detergent (closer to contemporary commonly-used dishwaster detergent tablets)
- repeatability and reproducibility improvements to testing methods.

No major effects are expected from these changes in the test standard. It is estimated that the energy consumption values reported could be slightly reduced by 0% – 6 %. However, final conclusions can only be taken once the final version of the common modifications of the IEC 60436 4th ed. (to EN 60436) have been decided, and once the first tests have been performed and correlated in independent laboratories and manufacturers' laboratories (which may result also in optimization of the loading plans or basket designs).

Verification tolerances have been revised, and are based on the relative expanded uncertainties from a round-robin test[7], including the combined cleaning and drying method, but not including the provisions of a new load and new detergent in the testing. A round-robin test on the final completely-revised harmonised standard should confirm these verification tolerances.

9. CONFORMITY ASSESSMENT

When performing the market surveillance checks – as referred to in Article 3 (2) of Directive 2009/125/EC - Member States'market surveillance authorities (MSAs) should apply the verification procedure prescribed for the requirements for Ecodesign and the Energy Labelling measures. These are described, respectively, in Annex V of the draft revised EU Ecodesign Regulation for household dishwashers and in Annex X of the draft revised EU Energy Label Regulation for household dishwashers.

The verification of measured resource efficiency parameters is proposed to be carried out as follows, with regard to verifying the compliance of a product model with requirements proposed in this Regulation, pursuant to Article 3(2) of Directive 2009/125/EC. For the requirements referred to under Annex I, Section 3 of the draft revised regulation, the following procedures should, at a minimum, apply:

point (1) 'Information requirements for refrigeration gases': Market surveillance authorities should access the relevant parts of the appliance (heat pump) and check that the chemical name of the principal component of the refrigerant gas is marked on the back panel of the appliance.

point (2) 'Requirements on design for dismantling for the purpose of de-pollution, and material recovery and recycling of household dishwashers': MSAs should disassemble, using commonly-available tools, the components specified under Annex I 3.(2) when present in the appliance, or a selection of them, following the manufacturer's instructions. MSAs must identify the type and the number of fastening techniques(s) to be unlocked, and tool(s) required.

point (3) 'Declaration of spare part availability: MSAs should identify that at the point of sale (at the retailer site or online) the requested information on spare part availability is visibly and legibly disclosed to the consumer and that this information is also in the booklet of instructions. MSAs should randomly and in an anonymised manner select and order those spare parts from the manufacturer or trade vendors that the manufacturer declares as necessary for the use of the appliance. MSAs shall then check that the correct delivery of the spare parts requested occurs.

[7] EN 50242/EN 60436:2016

point (4) 'Spare part maximum delivery time': MSAs should verify that the delivery time of the order of spare parts conducted under the previous point (3) has been delivered within three weeks. The date of the order should be the starting date of the three weeks period. If the contents of an order is correctly delivered, but is not delivered within the three weeks period, the MSA should repeat the verification with another test sample of spare parts. A manufacturer is deemed to have not met the requirements of the Regulation if, for the same product, more than three orders of spare parts do not meet the three weeks' maximum delivery time, unless there is an acceptable justification from the manufacturer of an event of force majeur.

point (5) 'Access to Repair and Maintenance Information': MSAs should verify that the access to all necessary repair and maintenance information is provided in an organised manner, and includes the information requested. The MSA may organise a blind test to verify that the information is accessible to independent operators in non-discriminatory conditions. MSAs should check the registry of requests in the required database on spare parts and check if declined requests relate to spare parts declared under (3).

If the compliance with the requirements above is considered as non-satisfactory, the market surveillance authority should take appropriate measures to ensure compliance. The manufacturer should then take subsequent corrective actions, amendments and/or supplements as requested by the market surveillance authorities and provide proof of compliance within a period of 1 month.

10. BENCHMARKS

The following indicative benchmarks have been identified for the purpose of part 3, point 2 of Annex I to Directive 2009/125/EC and refer to the best available technology (at the time of drafting this document), in terms of energy efficiency, energy and water consumption, cleaning and drying efficiency, airborne acoustic noise emissions and programme time of the standard (Eco) cycle for household dishwashers on the market.

(1) Household dishwashers with 14 place settings (**without** heat pump technology):

(a) Energy consumption: 0.67 kWh/cycle (overall annual energy consumption of 189 kWh/year (at 280 cycles per year))

(b) Water consumption: 9.9 litres/cycle (2,772 litres/year for 280 cycles)

(c) Airborne acoustic noise emissions: 44 dB(A)

(d) Programme time: 222 minutes (3 hours and 42 minutes)

(2) Household dishwashers with 13 place settings (**with** heat pump technology):

(a) Energy consumption: 0.55 kWh/cycle (overall annual energy consumption of 154 kWh/year (at 280 cycles per year))

(b) Water consumption: 8.8 litres/cycle (2,464 litres/year for 280 cycles)

(c) Airborne acoustic noise emissions: 44 dB(A)

(d) Programme time: 295 minutes (4 hours and 55 minutes)

(3) Household dishwashers with 10 place settings:

(a) Energy consumption: 0.66 kWh/cycle (overall annual energy consumption of 188 kWh/year)

(b) Water consumption: 9.5 litres/cycle (2,660 litres/year for 280 cycles)

(c) Airborne acoustic noise emissions: 44dB(A)

(d) Programme time: 195 minutes (3 hours and 15 minutes)

(4) Household dishwashers with 6 place settings:

(a) Energy consumption: 0.62 kWh/cycle (overall annual energy consumption of 174 kWh/year)

(b) Water consumption: 8.0 litres/cycle (2,240 litres/year for 280 cycles)

(c) Airborne acoustical noise emissions: 48dB(A)

(d) Programme time: 225 minutes (3 hours and 45 minutes)

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