



JRC TECHNICAL REPORTS

Follow-up of the preparatory study for Ecodesign and Energy Label for household washing machines and household washer dryers

Final report

Bennett M.J., Boyano A., Espinosa, N., Villanueva A. (JRC-EC)
(in alphabetical order)

2017

EUR 28807 EN

This publication is a Technical report by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policymaking process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of this publication.

Contact information

Name: Alejandro Villanueva
Email: Alejandro.VILLANUEVA@ec.europa.eu
Tel.: +34 9544-88485

JRC Science Hub

<https://ec.europa.eu/jrc>

JRC 2017

EUR 28807EN

PDF ISBN 978-92-79-73894-4 ISSN 1831-9424 doi: 10.2760/954441

Luxembourg: Publications Office of the European Union, 2017

© European Union, 2017

The reuse of the document is authorised, provided the source is acknowledged and the original meaning or message of the texts are not distorted. The European Commission shall not be held liable for any consequences stemming from the reuse.

How to cite this report: Bennett, M.J, Boyano A., Espinosa, N., Villanueva A. Follow-up for the preparatory study for the Ecodesign and Energy Label for household washing machines and household washer dryers, EUR 28807 EN, doi: 10.2760/954441

All images © European Union 2017,

Glossary

Washing performance classes	The level of soil removal that an appliance is able to achieve. The washing performance class of the appliance is rated in terms of a set of washing performance classes from A to G. A being the best class, G the worst one.
Dry spinning efficiency class	The level of remaining moisture in base load after spinning relative to the conditioned mass of the same load.
Standard programme	The programme(s) selected to measure the energy consumption and other performance parameters of an appliance
Household washing machine	an automatic washing machine which cleans and rinses household laundry by using water, chemical, mechanical, thermal and electric means; which also has a spin extraction function 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);
Household washer dryer	a household washing machine which, in addition to the functions of an automatic washing machine, in the same drum includes both a spin extraction function and a means for drying the textiles by heating and tumbling, 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.
Rated capacity	the maximum mass in kilograms stated by the manufacturer at 0.5 kg intervals of dry textiles of a particular type, which can be treated in one complete cycle of a household washing machine or a household washer-dryer respectively on the selected programme, when loaded in accordance with the manufacturer's instructions;
Programme	a series of operations that are pre-defined and which are declared by the manufacturer as suitable for washing, drying or continuously washing and drying certain types of textile;
Programme time	the time that elapses from the initiation of the programme until the completion of the programme excluding any end-user programmed delay;
Remaining moisture content	household washing machines the amount of moisture contained in the load at the end of the spinning phase, and for household washer-dryers the amount of moisture contained in the load at the end of the drying phase;
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

TABLE OF CONTENTS

LIST OF TABLES	VIII
1. CONTEXT OF THE PROPOSAL	11
1.1. Legal framework	11
1.2. Currently covered products	12
1.3. Reasons for and objectives of the revision.....	12
2. CONSULTATION OF INTERESTED PARTIES	12
3. REVIEW OF THE EXISTING ECODESIGN AND LABELLING MEASURES	13
3.1. Markets and performance of household washing machines and washer-dryers	13
3.1.1. Market data and trends regarding the rated capacity	13
3.1.2. Performance of household washing machines and household washer-dryers	14
3.1.2.1. Energy efficiency classes and energy consumption	14
3.1.2.2. Water consumption.....	18
3.1.2.3. Spin drying performance and spin speeds	20
3.1.3. Consumer behaviour	23
3.1.3.1. Household washing machines	23
3.1.3.2. Household washer-dryers	24
3.1.4. Technological improvement potential	24
3.1.4.1. Household washing machines	24
3.1.4.2. Household washer-dryers	28
3.1.5. Resource efficiency aspects	30
3.1.6. Summary of the revision.....	32
3.2. Policy scenarios for washing machines	34
3.2.1. Scenario 0: Business as Usual (BAU)	35
3.2.2. Scenario 1: Modifications of the testing standard for measurement to become more representative to actual consumer programmes use	35
3.2.3. Scenario 2: Ecodesign and revised scaling of the EU Energy Label	36
3.2.4. Scenario 3: Durability/repairability	40
3.3. Environmental significance of the proposed policy scenarios for washing machines	42
3.4. Policy scenarios for washer dryers.....	49
3.4.1. Scenario 0: Business as Usual (BAU)	50
3.4.2. Scenario 4: Modifications of the standard for measurement to bring it closer to actual consumption under real-life conditions	50
3.4.3. Scenario 5: Energy label and revised energy label scaling	51
3.5. Environmental significance of the proposed policy scenarios for washer-dryers.....	55
4. PROPOSED MEASURES.....	57
4.1. Scope and exclusions	57
4.2. Proposed Draft Measures: Ecodesign and Energy Labelling.....	58
5. FORM OF IMPLEMENTING MEASURES	62
6. IMPACT ASSESSMENT.....	62
7. POSSIBLE OVERLAP WITH OTHER ECODESIGN MEASURES	63
7.1. European legislation.....	63

7.2. International legislation.....	64
8. MEASUREMENTS AND CALCULATIONS.....	64
9. CONFORMITY ASSESSMENT	64
10. BENCHMARKS.....	65
11. REFERENCES	69
ANNEXES	70
ANNEX 1: ENERGY CONSUMPTION	70
11.1. Calculation of the Energy Efficiency Index (EEL _{40°C}) for washing machines and the washing process of washer-dryers	70
11.1.1. Calculation of the EEL _{40°C} : reference values (SCEC).....	72
11.1.1.1. Option A: three different linear SAE _c depending on the loading or a non-linear SAE _c	72
11.1.1.2. Option B: Weighting factors based on loading of washing machines	75
11.1.2. Calculation of the EEL _{40°C} : loading	76
11.2. Calculation of the EEL _{60°C}	77
11.3. Calculation of the Energy Efficiency Index (C) for washer-dryers	78
11.4. Low power modes for washing machines and washer-dryers.....	78
11.5. Minimum energy requirements for washing machines and washer-dryers.....	79
ANNEX 2 WATER CONSUMPTION	80
11.6. Water consumption	80
ANNEX 3 WASHING PERFORMANCE, RINSING PERFORMANCE AND DRYING PERFORMANCE.....	81
11.7. Washing performance	81
11.8. Rinsing performance	81
11.9. Spinning drying efficiency.....	81
ANNEX 4 OTHER ECODESIGN REQUIREMENTS RELATED TO THE PERFORMANCE OF THE WASHING MACHINES.....	83
11.10. Booklet of instructions.....	83
11.11. Washing cycle at 20°C.....	83
11.12. Arrow for identifying the testing programmes.....	83
11.13. Time indications, restrictions or time caps on programmes	84
11.13.1. Informative measures on the duration of the testing programmes	84
11.13.2. Inclusion of duration in the EEI as an additional parameter.....	85
11.13.3. Time restrictions	85
11.14. Information on hot-cold fill option	86
11.15. Recommendation on the loading of the machine	87
11.16. Other 40°C cotton programmes	87
11.17. Minimum temperature for the testing cotton programmes.	87
ANNEX 5: OTHER ECODESIGN REQUIREMENTS RELATED TO THE PERFORMANCE OF WASHER-DRYERS	89
ANNEX 6: RESOURCE EFFICIENCY REQUIREMENTS	90
11.18. Mandatory communication of a minimum list of instructions to users.....	90

11.19. Mandatory marking of Annex VII WEEE (2012/19/EU) components that are not present in all appliances, and are not visible from the outside	90
11.20. Requirements on design for dismantling for the purpose of depollution, material recovery and recycling of the appliance	91
11.21. Spare part availability time horizon declaration	91
11.22. Spare part maximum delivery time	91
11.23. Access to Repair and Maintenance Information (RMI)	91
ANNEX 7 ENERGY LABELLING REQUIREMENTS FOR WASHING MACHINES	93
11.24. Energy efficiency classes (values calculated based on the proposal, using loading factors) 93	
11.25. Spin drying efficiency classes	94
11.26. Information on the Energy label	94
ANNEX 8 ENERGY LABELLING REQUIREMENTS FOR WASHER DRYERS	97
11.27. Energy efficiency classes	97
11.28. Information on the Energy label: Washer-Dryers	97

List of tables

Table 1:	Overview of the current Ecodesign requirements for household washing machines and which EU Energy Label classes have been phased out	15
Table 2:	Comparison of possible policy scenarios for household washing machines	34
Table 3:	EU Energy Label class distribution without revision and three possible revisions of the Energy Label class corresponding to scenarios 2b1, 2b2 and 2b3.	37
Table 4:	Annual energy consumption of Best Available Technologies washing machines on the market in first quarter of 2017 (source Topten.ch)	37
Table 5:	Parameters changed in comparison to the BAU scenario for each of the scenarios 3a, 3b and 3c	42
Table 6:	Comparison of possible policy scenarios for household washer-dryers	49
Table 7:	Current energy label class distribution and for scenarios 5b1, 5b2 and 5b3.	52
Table 8:	Annual energy consumption of best available washer-dryers on the market in August 2017	52
Table 9:	Proposed Ecodesign and Energy label measures for washing machines and washer-dryers	58
Table 10:	Possibilities for the reference values of the EEI equation	72
Table 11:	Annual energy consumption of best available washer-dryers on the market in August 2017	74
Table 12:	Proposed weighting factor depending on the rated capacity of the machines	76
Table 13:	Proposed loading methods for testing the washing machines	77
Table 14:	Distribution of the washing machines regarding the spin drying performance index. (Source: CECED database 2015)	82
Table 15:	Possibilities for shorter the duration of testing programmes	86
Table 16:	Proposed energy efficiency classes for the Energy label for washing machines	93
Table 17:	Proposed acoustic airborne emission classes for the washing and spinning of the washing machines	95
Table 18:	Proposed energy efficiency classes for the Energy label for washer dryers	97
Table 19:	Proposed acoustic airborne emission classes for the washing, spinning and drying phases of the washer-dryers	98

LIST OF FIGURES

Figure 1:	Average rated capacity (kg cotton) of washing machine models	14
Figure 2:	Trend of average washing and drying capacities of washer-dryer models	14
Figure 3:	Distribution of energy efficiency classes for washing machines in 1997-2013 (CECED 2014)	15
Figure 4	Yearly energy consumption of washing machine models (5kg-10kg capacity range) on the market in 2014 as a function of their rated capacity, and current EU Energy Labelling classes and Ecodesign requirements (overlapping with Class A+).	16
Figure 5:	Progressive distribution of Energy Efficiency classes of washer-dryer models 1997-2013 (CECED 2014)	17
Figure 6:	Development 1997-2013 of the average energy consumption of "wash&dry" cycle per kg (above) and the overall energy consumption of the "wash&dry" cycle (below). Source:(CECED 2014)	18
Figure 7:	Development of average water consumption per cycle and per kg (CECED 2014)	19
Figure 8:	Average total water consumption of washer-dryer models (statistical results based on CECED 2014))	19
Figure 9:	Average specific water consumption of washer-dryer models (statistical results based on CECED 2014))	20
Figure 10	Distribution of spin drying performance classes for washing machines from 1997-2013 (CECED 2014)	21
Figure 11:	Development of average spin speed per cycle (CECED 2014)	22
Figure 12:	Trend of average maximum spin speed of washer-dryer models (CECED 2014)	22
Figure 13:	Washing programmes used; source: (Alborzi et al. 2015)	23
Figure 14:	LCC of single improvement options for WM (prices observed retail prices ORP per year of lifetime), and primary energy consumption over the lifetime	25
Figure 15:	Primary energy consumption vs. LCC of combinations of improvement options selected for WM	28
Figure 16:	Primary energy consumption vs. LCC of selected single improvement options for WD	29
Figure 17:	Primary energy consumption vs. LCC of combinations of improvement options selected for WD	30
Figure 18:	Estimated sales distribution for scenarios 2b1, 2b2 and 2b3	40
Figure 19:	Estimated average electricity consumption under real-life conditions (or actual use conditions) of a WM unit and total electricity consumption of the stock of WM in EU28 for scenarios 1a, 1b, 1c and 1d	43
Figure 20:	Estimated water consumption under real-life conditions of a WM unit for scenarios 1a, 1b, 1c and 1d	43
Figure 21:	Estimate consumer expenditure for the washing machine stock in EU28 compared to the BAU scenario for scenarios 1a, 1b, 1c and 1d	44
Figure 22:	Estimated average electricity consumption under real-life conditions of the stock of WM in EU28 for scenarios 2a, 2b1, 2b2 and 2b3	46

Figure 23:	Estimated water consumption under real-life conditions of a WM unit for scenarios 2a, 2b1, 2b2 and 2b3	46
Figure 24:	Estimated consumer expenditure over the lifetime of the washing machine stock in EU28 compared to the BAU scenario, for scenarios 2a, 2b1, 2b2 and 2b3	47
Figure 25:	Estimated number of jobs by 2030 in the washing machine sector (manufacturing and retail) in EU 28 under the conditions of the BAU scenario and scenarios 2a, 2b1, 2b2 and 2b3	47
Figure 26:	Estimated real-life water consumption of a WM unit for scenarios 3a, 3b, 3c and BAU	48
Figure 28:	Estimated sales distribution for scenarios 5b1, 5b2 and 5b3	54
Figure 29:	Estimated real-life average electricity consumption of a WD unit, and total electricity consumption of the stock of WD in EU28 for Scenarios BAU, 5a, 5b1, 5b2 and 5b3	55
Figure 30:	Estimated real-life water consumption of a WD unit for Scenarios BAU, 5a, 5b1, 5b2 and 5b3	56
Figure 31:	Estimate consumer expenditure for the washer dryers stock in EU28 compared to the BAU scenario for scenarios BAU, 5a, 5b1, 5b2 and 5b3	57
Figure 32:	Estimated number of jobs by 2030 in the washer drrs sector (manufacturing and retail) in EU 28 under the conditions of the BAU scenario and scenarios 5a, 5b1, 5b2 and 5b3	57
Figure 33:	Current energy consumption declared values and the SAE_c line	73
Figure 34:	Three proposed SCE_c (grey lines) depending on the rated (laundry load) capacity of the washing machines in the review study database	74
Figure 35:	Proposed non-linear SCE_c formulae for the washing machines in the review study database	75
Figure 36:	Proposed SCE_c when considering weighting factors based on observed consumer laundry loading patterns in the EEI calculation (grey line is the mathematical tendency and blue line is obtained by removing the outliers)	76
Figure 37:	Estimated energy consumption per kg of the washer dryers	79
Figure 37:	Estimated EEI values from the CECED database 2015	94

1. CONTEXT OF THE PROPOSAL

1.1. Legal framework

The Ecodesign Framework Directive 2009/125/EC establishes a framework for laying down Ecodesign minimum 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 should consider the implementation of appropriate measures. Household washing machines and household washer dryers belong to this list priority product groups, and the last Ecodesign regulation on washing machines has been in place since 2010 (see below), which is now subject to review, to take into account technological progress and purchase/ use patterns (as summarised in the Ecodesign Working Plan 2016-2019¹).

The application of the Ecodesign Directive is complemented by the Energy Labelling Framework Regulation (EU) No 2017/1369², which establishes a framework for the provision of accurate, relevant and comparable information on the specific energy consumption of products 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. As such, a proposal for an ecodesign regulation of a specific product group is often accompanied by a proposal for a Delegated Act that defines Energy Label requirements for the same product group (provided that there is a positive outcome of the Impact Assessment).

For Ecodesign and EU Energy Labelling measures related to household washing machines and household washer-dryers, the following regulations currently apply:

- Commission Regulation (EU) No 1015/2010 of 10 November 2010 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for household washing machines.
- Commission Delegated Regulation (EU) No 1061/2010 of 28 September 2010 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of household washing machines.
- Directive 96/60/EC of 19 September 1996 implementing Council Directive 92/75/EEC with regard to Energy Labelling of household combined washer-dryers.

¹ Communication from the Commission: Ecodesign Working Plan 2016-2019, COM(2016) 773 final, Brussels, 30.11.2016

² 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).

1.2. Currently covered products

The Regulations listed above cover electric mains-operated household washing machines and household washer-dryers, as well as those that are electric mains-operated but that can also be powered by batteries, including those for non-household use and for built-in appliances.

1.3. Reasons for and objectives of the revision

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

The revision of this policy resulted in the Commission Delegated Regulation 1061/2010, whose requirements remained in effect until the next revision.. In addition, in 2010, as the result of Commission Regulation 1015/2010, Ecodesign minimum requirements came into effect for household washing machines.. 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 rinsing and spin-drying efficiency and the potential for hot water inlets.

In addition, the 2010 Ecodesign regulation on household washing machines indicated that, in addition, household washer-dryers should also be addressed as soon as was feasible, by means of an implementing measure via Directive 2009/125/EC. For the time being, there are no Ecodesign requirements for household washer-dryers. Note that, separately, there is an existing energy label for household washer-dryers which was published as Commission Directive 96/60/EC (i.e., prior to the event of the Energy Labelling Framework regulation). This 1996 directive still applies, at present.

Starting in 2014, the Commission has undertaken a study to review these two existing regulations on household washing machines, and the existing directive related to energy labelling of washer-dryers. The conclusions of this study will be presented to stakeholders at a Consultation Forum meeting (established under Article 18 of the Ecodesign Directive 2009/125/EC) that will be held in December 2017.

2. CONSULTATION OF INTERESTED PARTIES

DG JRC led the revision process, a key element of which has been the 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/Washing_machines_and_washer_dryers/index.html.

Stakeholders have also had the opportunity 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 washing machines, washer-dryers and dishwashers.

DG JRC received technical and scientific support by 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 (1997-2014) by the industry association CECED³.

3. Review of the existing ecodesign and labelling measures

3.1. Markets and performance of household washing machines and washer-dryers

3.1.1. Market data and trends regarding the rated capacity

Household washing machines are widely present in European households, with an average household ownership rate of about 92%. In 2015, the EU-28 stock of household washing machines (WM) amounted to 201.4 million units. Thus, the 17.2 million new household washing machines sold on the market each year (2015 in the EU-28), are mainly replacement products for old and/ or broken, since the market is nearly saturated. machines.

Household washer-dryers (WD) have a much lower presence in European households. In 2015, the EU-28 stock reached 8.76 million units, bringing the household ownership rate to around 4%, but it is increasing. In 2015, yearly sales amounted to 0.88 million units in the EU-28.

The load capacity of washing machines and washer-dryers has changed gradually over the past few years (see. Figure 1 on WM and Figure 2 on WD). For household washing machines, the prevailing trend shows an increase in the market share of washing machines with higher average rated capacities⁴ (4.8 kg in 1998, increasing to over 7 kg in 2013). In 2013, the most common load capacity was 7 kg (31%). For household washer-dryers, the trend is similar. The average washing rated capacity was 4.9 kg in 1998, growing to 7.40 kg in 2013. Similarly, the average drying rated capacity has increased from 2.47 kg in 1998 up to 4.91 kg in 2013.

³ The European Committee of Domestic Equipment Manufacturers

⁴ i.e., the washing load for which the washing machine or washer dryer is designed. It depends on each specific washing programme. The value reported in this study refer to cotton laundry

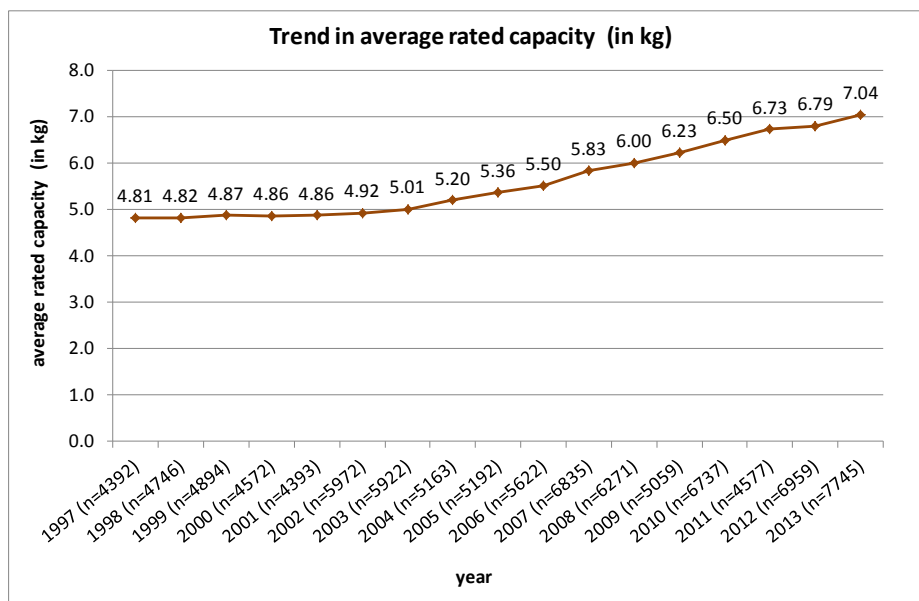


Figure 1: Average rated capacity (kg cotton) of washing machine models

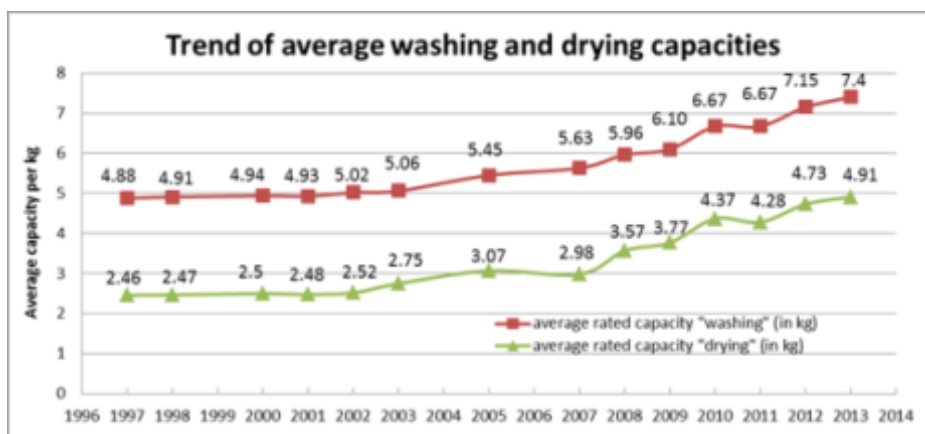


Figure 2: Trend of average washing and drying capacities of washer-dryer models

3.1.2. Performance of household washing machines and household washer-dryers

In 2015, the total electricity and waster consumption related to household washing machines in Europe was estimated to be 31.3 TWh and 2343 million m³, respectively. For washer-dryers, in 2015, the respective figures were 4.0 TWh and 152.5 million m³.

3.1.2.1. Energy efficiency classes and energy consumption

Energy efficiency in washing machines is measured using a fixed combination of the two "standard programmes", at 40°C and 60°C for cotton textiles and at two different loadings: full load and half load. These programmes were selected as the reference for the testing because they were considered as those programmes that better represent the most frequently used programmes by consumers.

The EU Energy Label efficiency class of a machine is determined by comparing the energy consumption of a machine's standard programmes with the average reference energy consumption of a machine of the same capacity (called standard annual energy consumption (SAE_c)).

Table 1 shows that, since December 2013, only three energy efficiency label classes (A+, A++ and A+++) have been allowed on the European market for washing machines with rated capacity ≥ 4 kg. In theory,

label class A is only allowed for washing machines < 4 kg. However, according to the CECED database, all 36 models of 4 kg WM and 4.5 kg WM on the European market are labelled A+.

Table 1: Overview of the current Ecodesign requirements for household washing machines and which EU Energy Label classes have been phased out

EU Energy Label Class	EEI	Ecodesign Tier I: Dec 2011	Ecodesign Tier II: Dec 2013
A+++	EEI < 46		
A++	46 ≤ EEI < 52		
A+	52 ≤ EEI < 59		
A	59 ≤ EEI < 68		Banned for all machines ≥ 4 kg
B	68 ≤ EEI < 77	Banned for all machines	
C	77 ≤ EEI < 87		
D	EEI ≥ 87		

The energy efficiency classes of washing machine models available on the EU market have evolved constantly over the past two decades (see Figure 3). The average declared energy consumption of standard programmes was reduced by half from 0.245 kWh per kg and cycle in 1997, to 0.120 kWh per kg and cycle in 2013. In 2013, 50% of the washing machine models available on the market had already achieved EU Energy Label class A+++ (CECED 2014).

Note that Figure 3 shows the number of models on the market - this does not necessarily reflect sales figures.

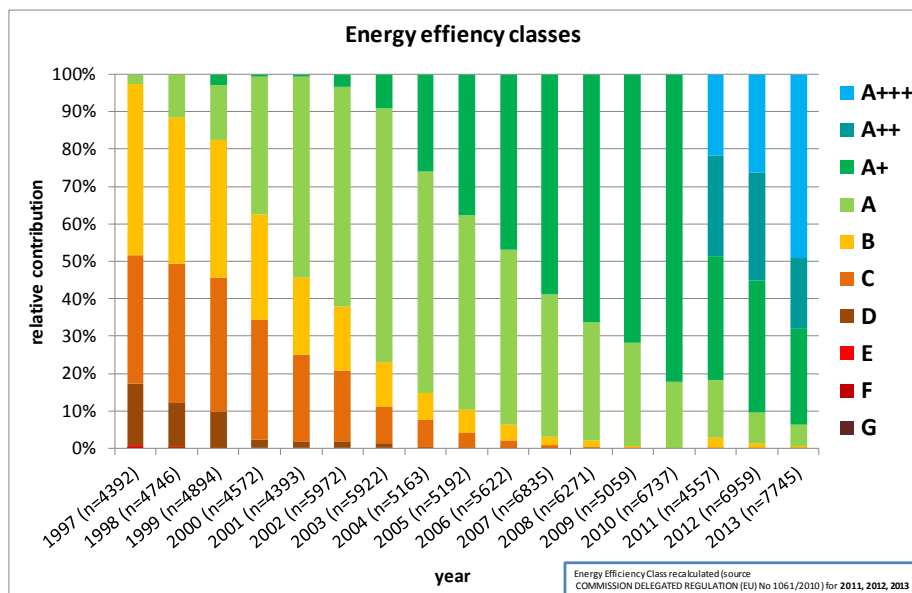


Figure 3: Distribution of energy efficiency classes for washing machines in 1997-2013 (CECED 2014)

To illustrate the development of washing machine energy efficiency compared to the current ecodesign and energy label requirements, Figure 4 shows a sample of washing machines models ≥ 5 kg sold in the EU market in 2014 (from the CECED database). The figure shows that a large share of washing machines far exceed the best Energy Efficiency Class, A+++.

capacities. On the other hand, only a few of the smaller machines (<5 kg) achieve Energy Efficiency Classes better than A+++.

However, it should be noted that Figure 4 shows yearly energy consumption under the testing and declaration regime of the existing standard programmes. Under real-life use conditions, the distribution of energy efficiency may be different.

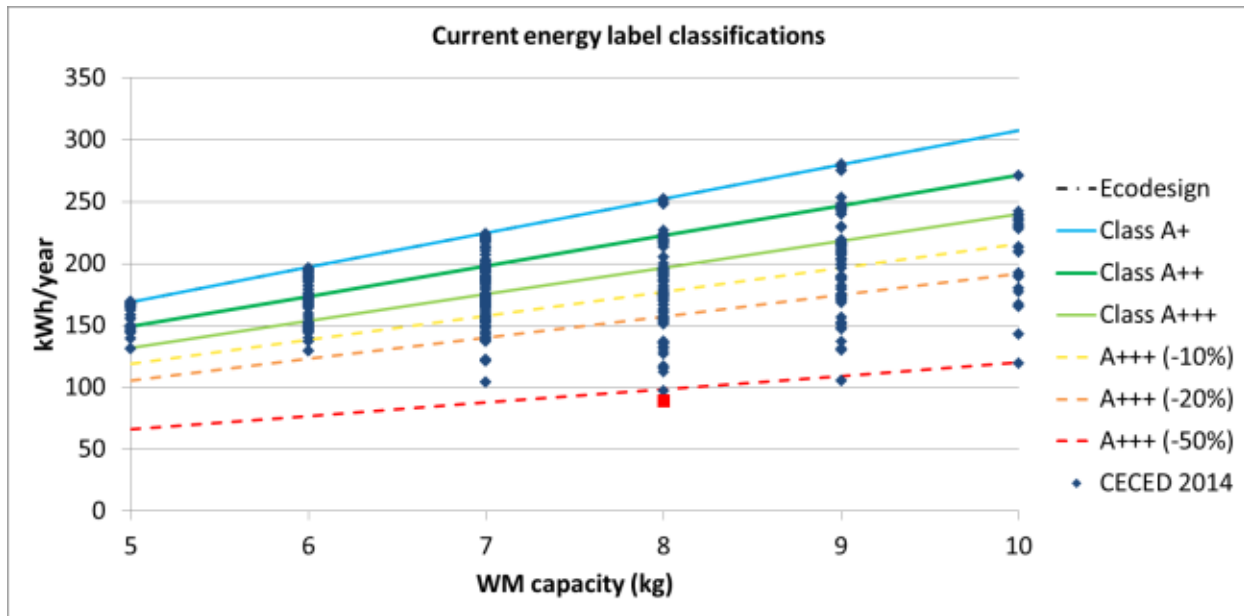


Figure 4 Yearly energy consumption of washing machine models (5kg-10kg capacity range) on the market in 2014 as a function of their rated capacity, and current EU Energy Labelling classes and Ecodesign requirements (overlapping with Class A+).

In the EU, the washing machine market has been strongly influenced by the Ecodesign and Energy Label regulations. The above information clearly illustrates that, for the past few years, most machines have been labelled A++ or A+++. Therefore this has now resulted in the policy being a "victim of its own success", as there is presently little market differentiation of WM based on the EU Energy Label.

At first glance, it may seem necessary to update the scale and set more stringent minimum energy performance standards (MEPS). However, some additional considerations are key to understanding the current market situation and label claims. Firstly, it is important to note that for a large number of machines on the market, the products' rating in the better energy classes has been achieved by means of extending the duration of standard programmes (>4h). However, although this seems to represent progress, in reality consumers have tended not to use these programmes under actual use conditions. In addition, the top energy classes are, in some cases, only reached under full loading of very large drums (>9kg), which consumers seldom need, or in fact use.

Washer-dryers placed on the market between 1997 and 2013 have also substantially improved in terms of energy efficiency (see Figure 5). Washer-dryers classified with energy efficiency class A entered the EU market in 2007 and reached over 50% of the EU market share by 2013 (CECED 2014).

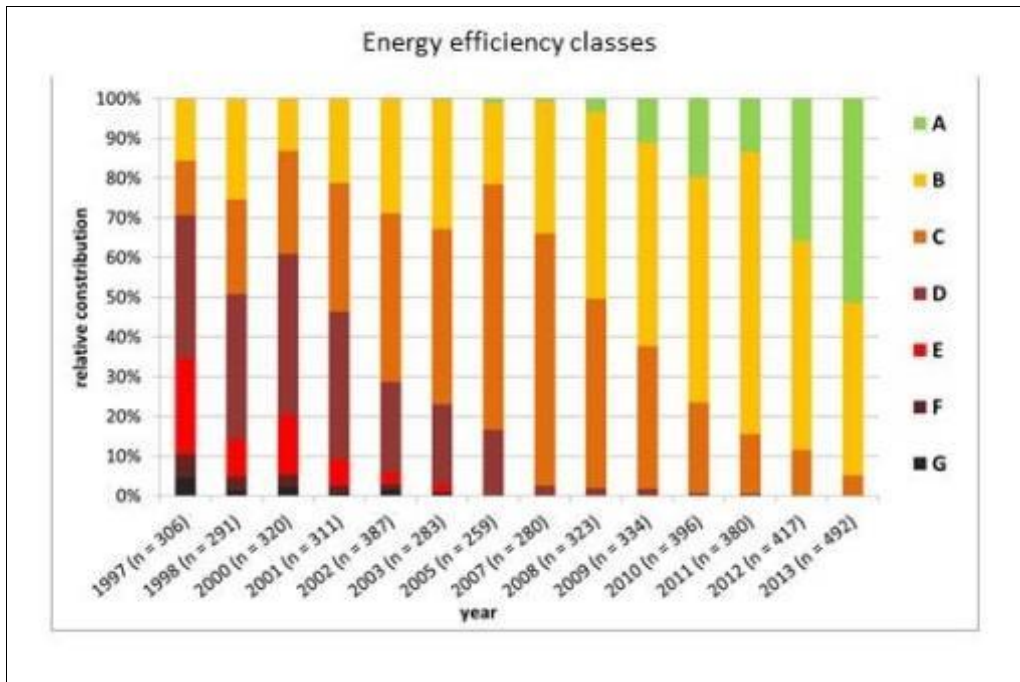


Figure 5: Progressive distribution of Energy Efficiency classes of washer-dryer models 1997-2013 (CECED 2014)

Recent user surveys indicate that manufacturers have designed the washing conditions of "standard cotton programmes" with energy use optimisation in mind, in order that machines are able to receive the best possible EU Energy Label, at the moment of purchase. However, these design strategies have often led to longer washing programmes that, in reality, consumers use less frequently. It has been shown that for convenience, consumers often choose less energy-efficient (e.g. shorter) programmes, and frequently run their WM only partially loaded. (These consumer behaviour patterns may, understandably, also be related to historical, greater familiarity with shorter washing programmes from past experience). As a consequence, the actual energy and water consumption under real-life conditions of household washing machines is, on average, 30% higher than the value of those figures displayed on the EU Energy Label declaration. This value is based, therefore, for the time being, on water and energy optimised programmes that are only partially used.

Household washer-dryers have higher average energy consumption values than washing machines, since they also dry the textile load. Considering the "wash&dry" cycle (washing and drying of the whole load), absolute energy consumption increased by 0.5 kWh per cycle from 1997 to 2013 (4.95 to 5.44 kWh/cycle). This is due to the increased capacity of the machines on offer, over time. However, the specific energy consumption (per kg of laundry) has shown steadily declining values, from 1.02 kWh/kg in 1997 down to 0.74 kWh/kg in 2013 (see Figure 7).

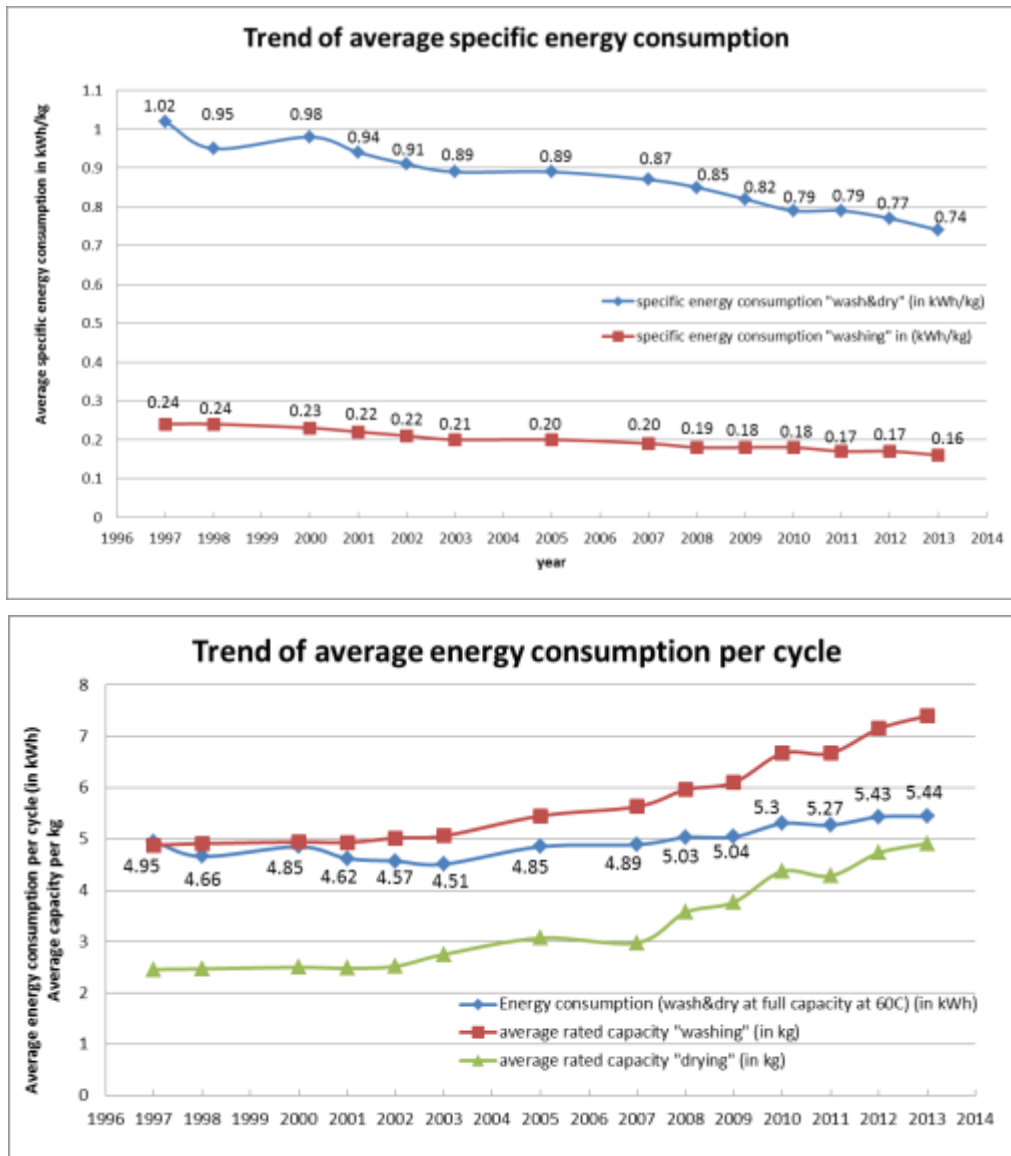


Figure 6: Development 1997-2013 of the average energy consumption of "wash&dry" cycle per kg (above) and the overall energy consumption of the "wash&dry" cycle (below). Source:(CECED 2014)

3.1.2.2. Water consumption

Washing machines' average water consumption *per cycle* has significantly declined between 1997 and 2005, but has since then stabilized (Figure 7). By contrast, water consumption *per kg* of rated capacity has steadily decreased, from 13.9 litres/kg in 1997 to 6.5 l/kg in 2013. The difference in the results expressed per cycle and per kg is due to the increased average rated capacity (in kg load) of washing machines.

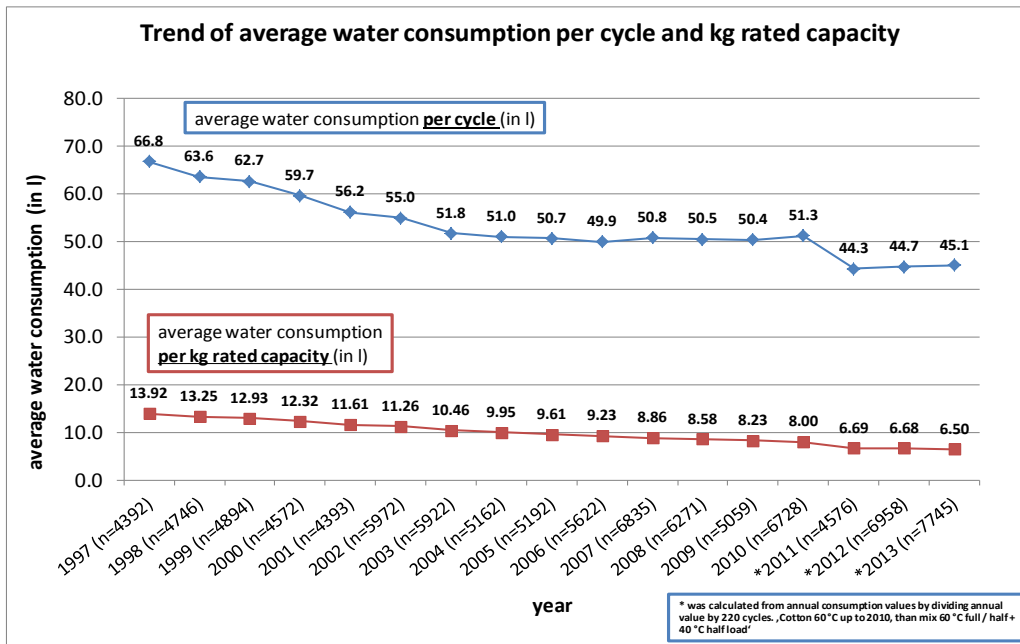


Figure 7: Development of average water consumption per cycle and per kg (CECED 2014)

For household washer-dryers, the average water consumption of the "wash&dry" cycle declined from 129.7 litres/cycle in 1997 to 98.1 litres/cycle in 2013 (see Figure 8). This represents an improvement of 24%. Nevertheless, most washer-dryers on the market still consume around twice as much water as a washing machines of the same capacity. Perhaps counter-intuitively, this is due to the need for additional water to cool down the air in the drying process (only washer-dryers equipped with air/air condensing or heat-pump drying do not use water during this stage). The average specific water consumption rate per model capacity has been reduced by half from 26.8 litres/kg in 1997 down to 13.4litres/kg in 2013 (see Figure 9). This is again due to a combination of lower absolute values, but increased capacities, over time.

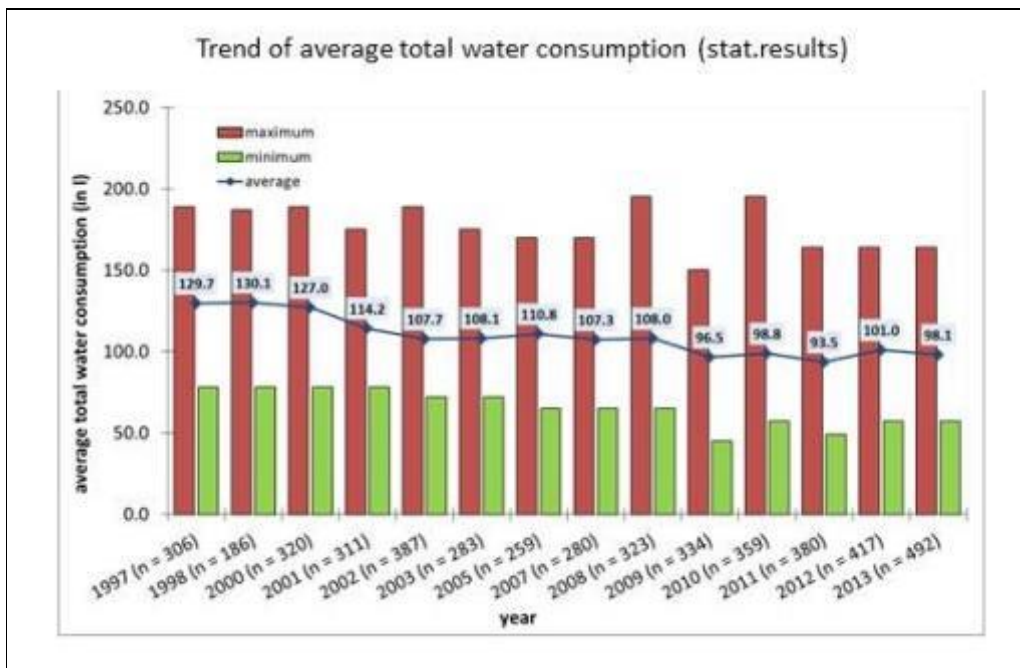


Figure 8: Average total water consumption of washer-dryer models (statistical results based on CECED 2014))

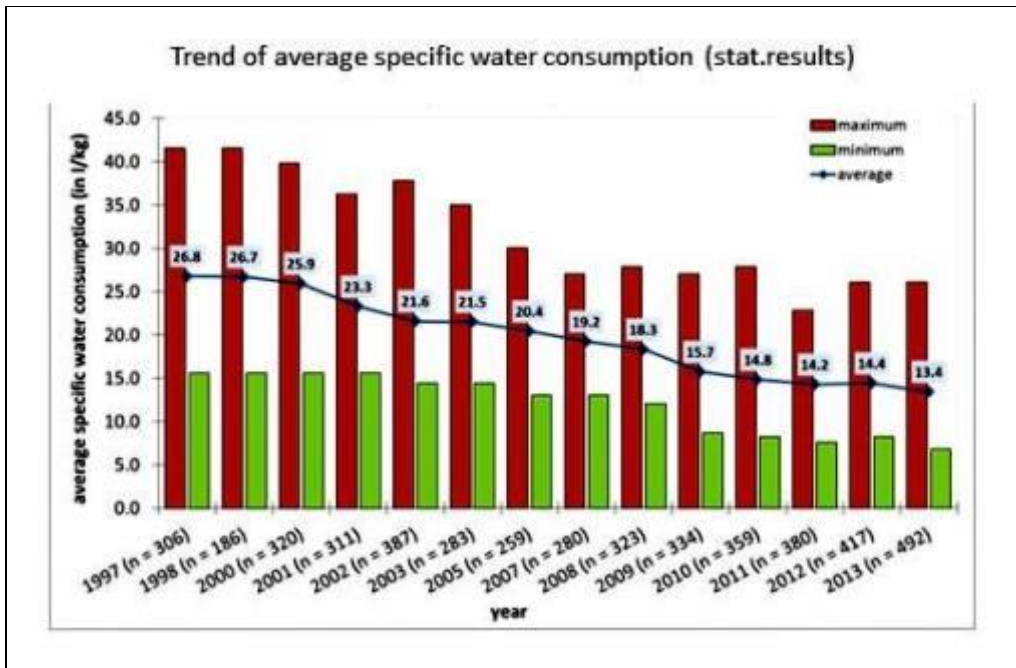


Figure 9: Average specific water consumption of washer-dryer models (statistical results based on CECED 2014))

3.1.2.3. Spin drying performance and spin speeds

Washing Machines

According to the EU Ecodesign Regulation (EU) No 1015/2010, its subsequent revision over time had to assess, inter alia, the opportunity for setting requirements on spin-drying efficiency. Spin-drying performance ("efficiency" in the current wording) is part of the information displayed on the label. The spinning performance is expressed via an A-G scale, with A being the best performing class. Currently, there are no ecodesign requirements on spin-drying performance.

Spin-drying is an energy-consuming function. However, spin-drying is more efficient than tumble drying in terms of energy consumption. Thus, if consumers use both a washing machine and a tumble dryer or they dry the laundry in a heated room, improving the performance of the spinning prior to placing the wash load in the tumble dryer or in the heated room can bring about overall energy savings. However, higher spinning speeds can produce more creasing (wrinkle formation), which is not ideal when line-drying, and may subsequently require more use of relatively higher energy-intensity ironing, to "iron out" the creases..

According to the CECED (2014) database, in 2013 around 56% of washing machine models fell into spin drying class B, 18.5% in class A and 20% in class C. Products in the other spin drying performance classes account for the remaining 5% product distribution (see Figure 10).

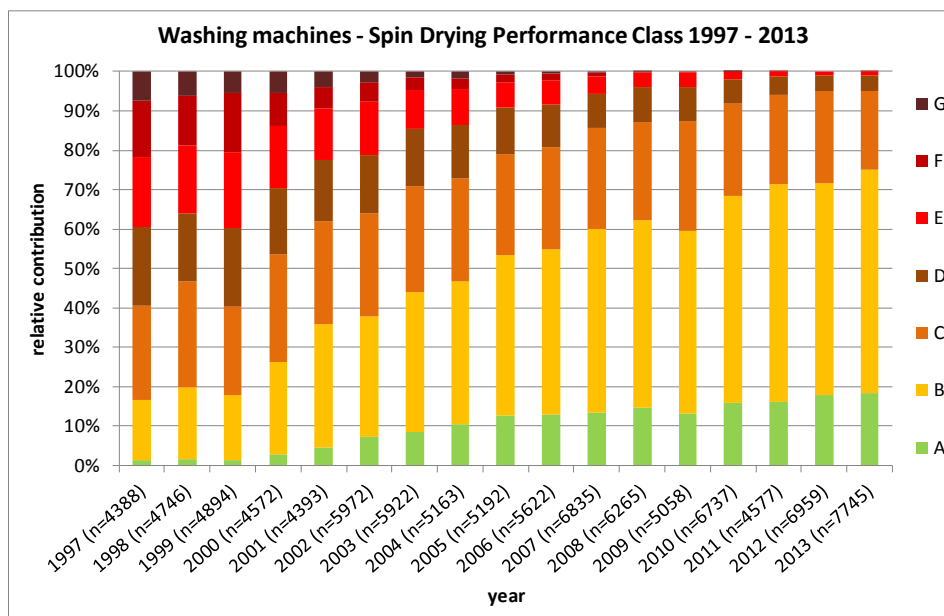


Figure 10 Distribution of spin drying performance classes for washing machines from 1997-2013 (CECED 2014)

Spin speed is a main driver for the drying efficiency value. The more the laundry is spun, the less energy is subsequently needed to dry it. Figure 11 shows a clear trend of substituting low spin speed machines (at 900 rpm or lower) with higher spinning machines. These results illustrate a steady increase in the average spinning speed from just over 800 rpm in 1997 to slightly more than 1200 rpm in 2010.

According to the available data, the maximum spin speed of machines is 1000-1600 rpm. The proportion of machines with spin speeds of less than 1000 rpm has decreased over the last decade, and the market share is negligible for maximum spin speeds in excess of 1600 rpm. Machines with 1800-2000 rpm appeared on the market at the end of 1990s, but they disappeared because higher spin speeds barely reduce the remaining moisture but do significantly increase product costs. Additionally, safety requirements impose limits on the maximum spin speed⁵.

Given users' different needs in terms of drying and spinning, together with geographical (e.g., availability of sun for natural line-drying) and possibly socio-cultural (time, tradition) effects, assessing possible tradeoffs is complex, with high uncertainty and variability. Taking line-drying and ironing (together with changes in the materials used commonly for clothes) into account, as well as the market transformation observed with the use of the energy label, it is suggested that the current information on spin-drying efficiency classes should be removed from the Energy Label and kept in the product information sheet. One progressive change is that the spin-drying efficiency information should be accessible through a QR code on the energy label. It is suggested to refrain from putting in place Ecodesign requirements on spin-drying.

⁵ Danger comes from the fact that centrifugal force does not increase in direct proportion to an increase in speed, but instead it increases as the square of that speed increase. When rotational speed doubles, centrifugal force quadruples. This effect means that relatively small changes in speed can produce significant increases in force

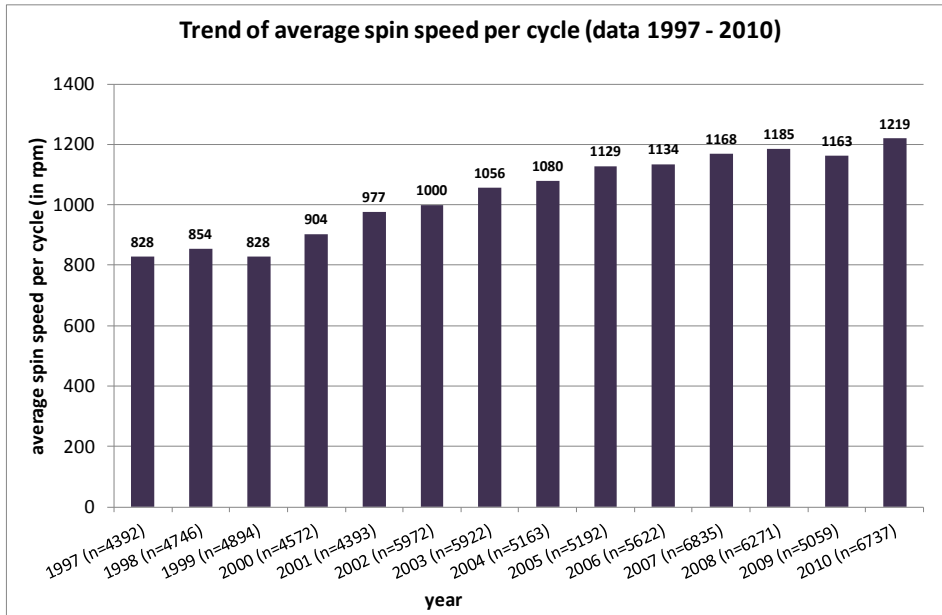


Figure 11: Development of average spin speed per cycle (CECED 2014)

Household washer-dryers

For household washer-dryers, the picture is slightly different, as the use of so-called "wash&dry" programmes benefit from higher spin speeds. Figure 12 shows a continuous increase in the average maximum spin speed from circa 1102 rpm in 1997 to circa 1400 rpm in 2013.

In 2013, over 60% of the machines had a spin speed of around 1400 rpm, just over 15% of the machines had spin speed declarations of 1200 rpm and 1600 rpm. Note that less than 5% had declared spin speeds of higher than 1600 rpm.

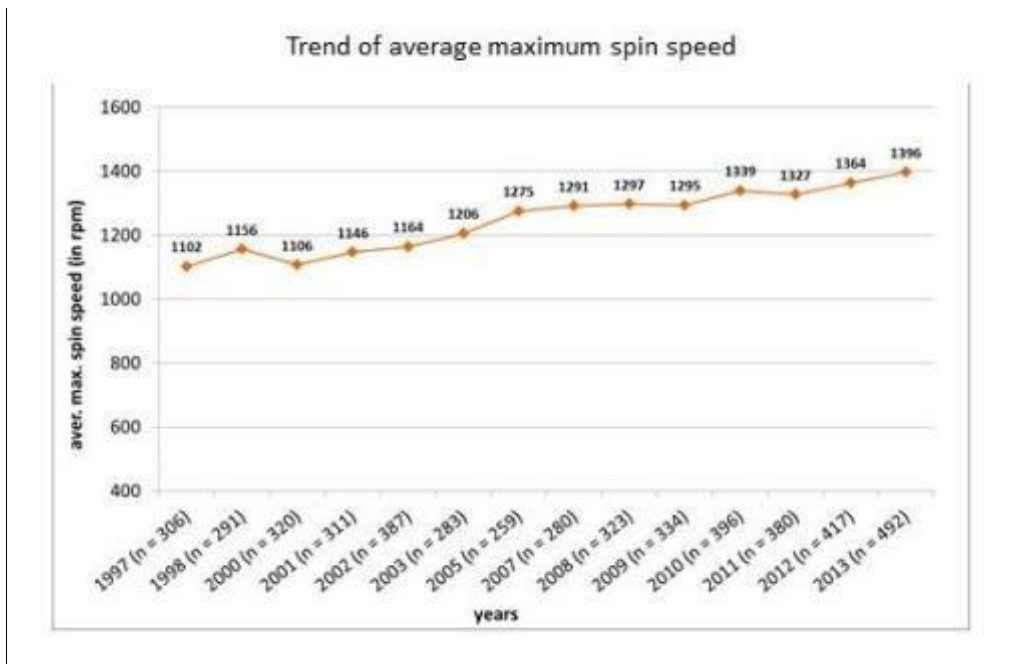


Figure 12: Trend of average maximum spin speed of washer-dryer models (CECED 2014)

3.1.3. Consumer behaviour

3.1.3.1. Household washing machines

In 2015, the University of Bonn conducted a European wide consumer survey of 5,000 household washing machines and household washer-dryers in 11 countries. The main outcomes of the survey are summarised below.

Washing programmes used

Cotton wash programmes were reported as being the most commonly used washing programmes (62% of all washing programmes used are for cotton, as shown in Figure 13). Within this share of cotton programmes, the "normal cotton programmes" accounted for 26%, with "Cotton 40 °C" being the most frequently used programme (15%) and "Cotton 60 °C" the second most popular (11%).

It should be highlighted that the two "Standard cotton programmes (40°C and 60°C)" together accounted for 17% of the programmes used (Standard cotton 40°C: 10%; Standard cotton 60°C: 7%). This is of high interest, since these two programme are part of the current basis for testing, and are used to determine the Energy Label class assigned to each washing machine, .

Two other frequently used non-cotton programmes were "Synthetic/Easy care 30°C/40°C" (11%) and "Quick wash/Short" (13%). Figure 13 shows that "Cotton 90°C" (5%) and "Cotton 20°C" (4%) were the least-used washing programmes.

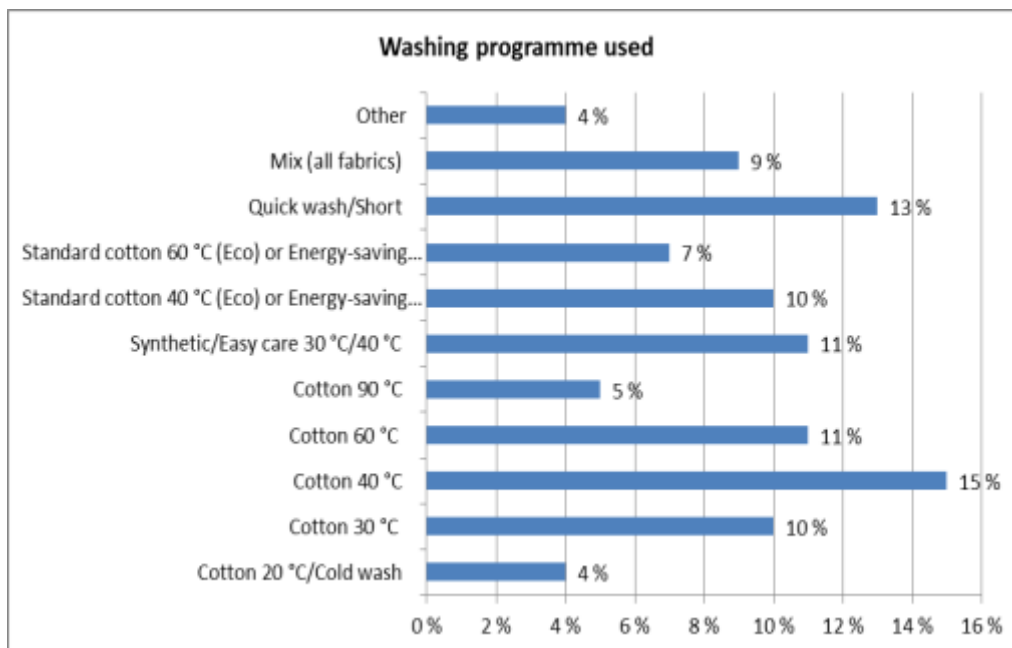


Figure 13: Washing programmes used; source: (Alborzi et al. 2015)

Other key results from the user survey:

- For consumers, "cleaning" was the most important characteristic of the washing programme. In addition, the most important features that consumers take into account before purchasing a washing machine were "Low energy and water consumption and associated bills", "Purchase price", "Simple and easy to use", "Expected rinsing results and washing performance", "Low noise emission" and "Short programme duration".

- For consumers, it is preferable to provide energy and water consumption information per cycle rather than per annum.
- For survey participants, the average capacity of washing machines was 6.5 kg.
- Consumers do not always understand which programmes are those which are more energy efficient. Around 40% of respondents were not aware that longer washing programmes save more energy and that, inversely, shorter programmes at the same temperature use more energy (as it is explained by the so-called "sinner cycle").
- Short programme duration was one of the most important aspects for consumers when deciding to buy a new washing machine or selecting a washing programme. The majority of respondents used washing programmes that lasted less than three hours.
- The lifetime of the machine was a relevant purchase criterion for washing machines. Some consumers regard it as the most important criterion. In order for the majority of consumers to understand and be able to use this information, the Energy Label would need to be altered/improved.

3.1.3.2. **Household washer-dryers**

The main outcomes of the consumer survey on washer-dryers were:

- Washer-dryers were mainly used for washing. The average number of washing and/or drying cycles of a washer-dryer per household was 4.6 wash cycles per week, of which 1.5 wash cycles were of the continuous "wash&dry" option. The average number of drying cycles per week was 2.9.
- Around 90% of all washer-dryers in the survey had a continuous wash&dry option.
- The average rated capacity of the washer-dryers in the surveyed households was: washing capacity 6.9 kg, drying capacity 5 kg and wash&dry capacity 5.3 kg
- The most acceptable option for consumers for saving energy and money was the energy saving programme. Longer programme cycles represented the least popular option, with 70% of respondents admitting stating that they would accept a maximum of three hours for a continuous wash&dry cycle. These results confirm that despite consumer willingness to save water and energy by using energy saving programmes, they do not want programmes to last too long.
- In terms of water and energy consumption and programme duration of different cycles, 50% to 70% of respondents preferred to see consumption data expressed as "per cycle" rather than as "annual consumption levels", or consumption on the basis of "per kg of laundry".
- Important items of information to display on the future EU Energy Label (referring to the continuous wash&dry cycle) were, in descending order: energy efficiency, capacity in kg, programme duration (hours:minutes) and energy consumption per cycle.

3.1.4. **Technological improvement potential**

3.1.4.1. **Household washing machines**

Different technological improvement options for washing machines and washer-dryers were analysed in the review study. Improvements were compared to the base case (a washing machine with 7 kg capacity and a washer-dryer with 7 kg washing capacity).

For **single improvement options for household washing machines**, the biggest differences were observed after the options "installation of a heat pump" or use of a "consumer feedback information system". These options led an increase in the loading of the machine and led to relatively high savings in the impact categories of total energy use, and electricity consumption. Figure 14 depicts the primary energy consumption and the life cycle costs (based on observed retail price [ORP] per year of lifetime) for the full range of single improvement options.

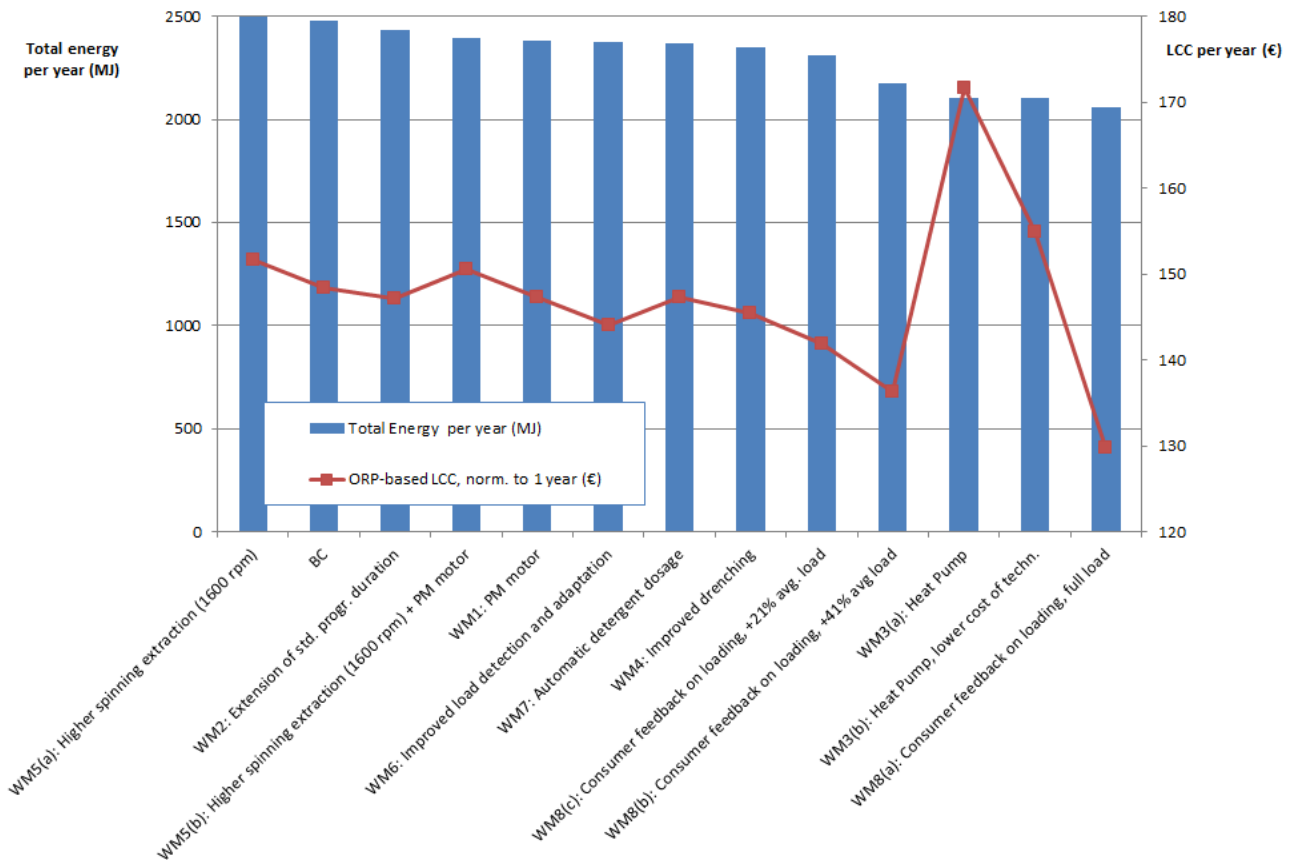


Figure 14: LCC of single improvement options for WM (prices observed retail prices ORP per year of lifetime), and primary energy consumption over the lifetime

According to the analysis, the option "consumer feedback on loading with hypothesis of full load" (WM8a) is both the best available option in terms of energy savings and lowest life cycle cost (LLCC). Therefore, it is the most cost-effective. The potential of load adaptation as a purely technological option (WM6) is much more limited. However, full loading of machines appears to be unrealistic, considering consumers' washing requirements and habits. The partial fulfilment of this measure has been studied, e.g. (increase of 41% (WM8b) or 21% (WM8c) of the base case load). These options still rank high in terms of life cycle cost.

The high-technological option (WM3a) of equipping the washing machine with a heat pump also results in high potential savings in the impact categories total energy use and electricity consumption, hazardous waste, GWP, and VOC emissions (varying, between 5% and 13% in the various impact categories). Conversely, this option has high additional impacts in the impact categories of process water use, non-hazardous waste production, POPs and heavy metals (both to air and to water), as well as a very high LCC, for which the consumer would not get a full return on investment, even in an optimistic scenario of technology cost reduction (WM3b).

Among the other options considered:

- The design options "*Extension of standard programme duration*" (WM2), "*Improved load detection and adaptation*" (WM6), "*Permanent magnet motor*" (WM1), "*Improved drenching*" (WM4) and "*automated detergent dosage*" (WM7) provide additional energy savings with relatively limited investment.
- "*Higher spin extraction with spin speed of 1600 rpm*" (WM5) is less interesting, since it adds structural complications and costs with no, or limited improvement in terms of energy gains.

The life cycle costs for all the single design options, except for the heat pump, are of the same order of magnitude. They range from 0.4% to 2% of the LCC of the Base Case (BC). Taking into account, uncertainties, especially regarding cost data, the differences are not significant. The single design option with the highest LCC is the heat pump, which mainly results from the higher purchase price compared to the Base Case (+101%). The LCC increased by 16% to 23 % (depending on assumptions regarding the purchase price). The high purchase price is to some extent compensated for by the savings in electricity costs during the use phase of the washing machines equipped with this technology (-10%). Note that the estimated reductions in electricity consumption and the associated costs have been calculated by assuming a mix of programmes, according to consumer behaviour patterns observed.

Following the recommendation of the EU Ecodesign Regulation (EC) No 1015/2010 for household washing machines, this review study specifically analysed the potential for **hot water inlets**. The review study concluded that both hot/cold-filled appliances, as well as heat-fed appliances, would make it possible to feed the washing machines with hot water, thus replacing some of the electricity used to heat up the water (at least for the range of temperatures between 20°C and 60°C). Implications on machine design are limited in terms of the bill of materials, and could increase manufacturing costs by c.irca 20€ (second water inlet, valves, hoses, wiring, and control). To supply heat-fed machines, a heat-exchanger (approx. 60€-100€) and an external connection to a hot-water system (approx. 200€) would be needed. The potential gains of hot water inlet appliances for consumers depend on specific site conditions, and on parameters such as the length and the insulation of the hot water pipes used, as well as the efficiency and control system of the associated circulation pump (if one is utilised), and the efficiency of the existing or projected water heating sources (e.g. gas boiler, off-peak electric, solar, gas, electric, etc. source).

Based on the above-referenced options, the maximum estimated energy-saving potential that could be achieved by hot-cold fills is between 37% and 49% (assuming there is an existing solar energy system that does not require an (extra) new installation or new infrastructure).

Given the variable conditions for consumers to meet the optimal conditions described (e.g. short and well-insulated pipelines, high-efficiency water boilers, provision of renewable energy sources to heat-up the water, etc.) and given the variety of installations and boilers used in houses and the complexity of assessing possible trade-offs, the suggested conclusion is that it is not advisable to set stronger requirements at this stage. Additionally, the market share of appliances that are compatible with hot water inlets is currently very low, although an increase is expected in the near future in relation to the installation of renewable energy technologies in the residential sector (as supported by Art 13(4) of Directive 2009/28/EC⁶). For these reasons, it is proposed to strengthen the provision of information about the suitability, under certain conditions, of using an external hot-cold fill inlet. The provision of information could be proposed as an Ecodesign requirement.

Regarding **combinations of improvement options** for household washing machines, the review study revealed that (see Figure 15):

⁶ Directive 2009/28/EC on the promotion of the use of energy from renewable sources.

- WM-C8 "consumer feedback on loading with hypothesis of full load" is the best available design option in terms of energy savings. This is a top model that includes the following improvement options: permanent magnet motor, improved drenching, improved load detection and partial load adaptation, automatic detergent dosage and consumer feedback on loading (but loading behaviour remaining unchanged) **with additional hot-cold fills** (assuming heating from renewable sources already installed). For the hot-cold fill it is assumed that all heating energy comes for free (from existing solar heating), without considering additional system aspects (i.e. heating system, alternative supply of energy, water supply network, or losses of energy). This combination is thus the maximum saving potential achievable for washing machines via technology improvements alone. In reality, the implementation of this option is, for the time being, very limited and might not be possible for most dwellings, which in reality would require some adaptations (e.g. partial/full replacement of a fossil-based water heating system).
- WM-C7 "automated detergent dosage" is the second best available combined design option in terms of energy savings. This refers to a top model that would include the following improvement options: permanent magnet motor, improved drenching, improved load detection and partial load adaptation, automatic detergent dosage and consumer feedback on loading (but loading behaviour remaining unchanged) **with an additional heat pump**. This option currently represents a niche market and comes with an increased LCC that few consumers would be currently willing-to-pay. From an economic point of view, this option would be more attractive if the cost of technology were cheaper. Other drawbacks of this option are its mechanical, maintenance and repair complexity, the presence of two heating systems (firstly the heat pump, and secondly electrical resistance), the slower warming speed, the reduced capacity for a washing laundry load and the challenge of end-of-life considerations.
- The two combined options that produce the two lowest LCCs were WM-C6(b)⁷ and WM-C5(a)⁸. These combined design solutions rely on a dramatic change in user behaviour (i.e. design options where the loading conditions are increased by 41%). Eliminating behavioural aspects, the lowest LCC option is WM-C8 (see above), followed by WM-C6(a)⁹. In the case of hot-fill and use of conventional water heating systems, option WM-C8 would be still comparable to the Base Case.
- With the exception of incorporating a heat pump into the product, and by definition, the option of a rated load capacity increase, energy and economic savings can be achieved via all the analysed design options without the need to increase the loading conditions, although benefits would be greater with higher wash loads.

⁷ WM-C6(b) includes the following technologies: PM motor, improved load detection and adaptation, improved drenching, automatic detergent dosage and consumer feedback on loading (assuming that the load increases 41%)

⁸ WM-C5(a) includes the following technologies: improved load detection and adaptation and consumer feedback on loading (assuming that the load increases 41%)

⁹ WM-C6(a) model including the following improvement options: permanent magnet motor, improved drenching, improved load detection and partial load adaptation, automatic detergent dosage, consumer feedback on loading, but consumer behaviour on loading still unchanged

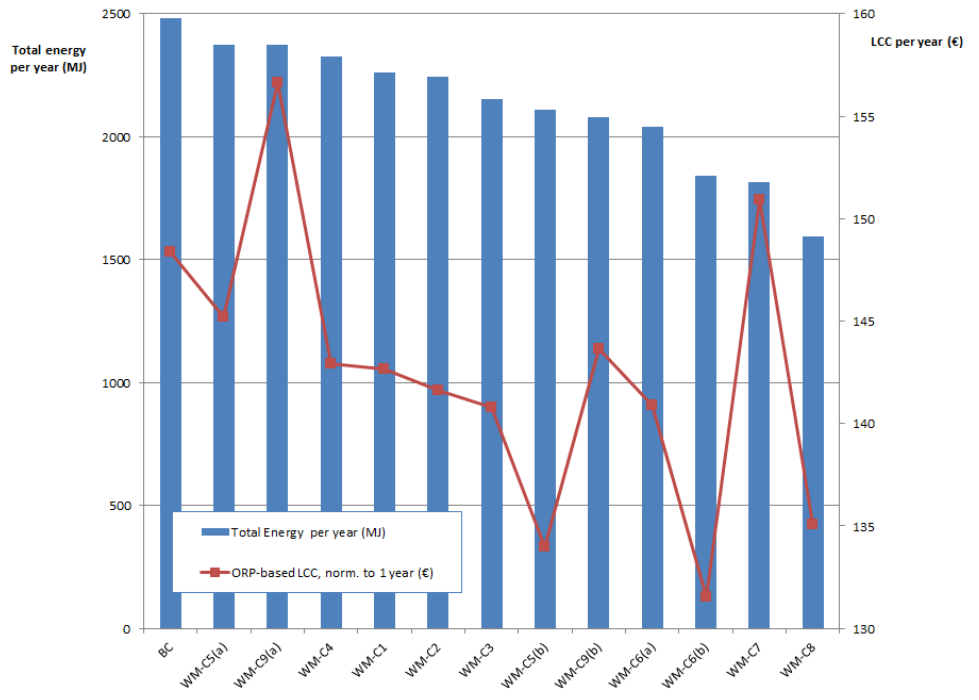


Figure 15: Primary energy consumption vs. LCC of combinations of improvement options selected for WM

3.1.4.2. Household washer-dryers

Different technological improvement options for household washer-dryers were analysed within the review study, but in general, the observations and conclusions drawn for the single design options assessed for washing machines apply also to washer-dryers.

It should be noted that all the single design options assessed reduce the LCCs. Using a heat pump for drying (WD2a) is both the best design option in terms of energy savings, and represents the lowest LCC option. This option would be even more attractive if the cost of the technology could be decreased (WD2b). An appreciable reduction of the LCC is also possible through an air condensing system (WD1), realised via savings in the water utilised.

The other two options studied ("Improved design of the combined wash&dry cycle" [WD3]), and "Higher spinning extraction plus permanent magnet motor" [WD-WM5b]) show lower savings potentials in comparison with the Base Case. In particular, it should be noted that the improved design to the combined wash&dry programme is an option that has no additional cost. However, its potential to reduce environmental impacts and costs for consumers relies on the actual use of these programmes in real-life.

For household washer-dryers, Figure 16 represents primary energy consumption, together with the LCCs based on the observed retail price (ORP), normalised per year of use, and calculated for the **single improvement options for household washer-dryers**

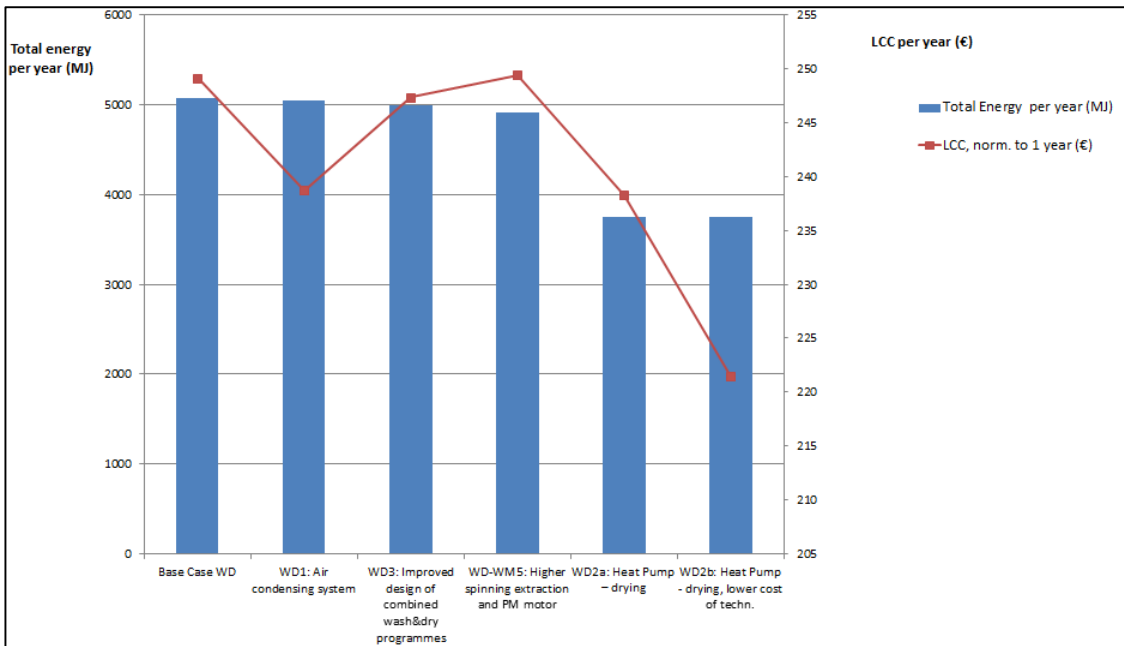


Figure 16: Primary energy consumption vs. LCC of selected single improvement options for WD

Regarding **combinations of improvement options** for household washer-dryers, the review study revealed that (see Figure 17):

- WD-C6¹⁰ is both the best available combined design option in terms of energy savings and the lowest LCC design option. This is a top model that includes, among other improvement options, a heat-pump for the drying process, improved design of the wash and dry process, a consumer feedback mechanism on loading and an automatic detergent dosage system.
- WD-C3¹¹ is the second best design option and still uses a heat pump to achieve the drying process, an improved design for the wash and dry process, and a more limited set of improvement options for the washing phase.
- Economic and energy savings can be achieved through all the design options analysed without the need to increase loading conditions. The presence of an air-based condensing system, in particular, seems to be more convenient from a LCC perspective than the water-based condensing system (i.e., WD-C2¹² vs WD-C1¹³, and WD-C5¹⁴ vs. WD-C4¹⁵).

¹⁰ WD-C6 includes a permanent magnet (PM) motor, improved load detection and adaptation, improved drenching, automatic detergent dosage and consumer feedback on loading, improvement of the drying phase through heat pump and combined wash&dry programme

¹¹ WD-C3 includes PM motor, improved load detection and adaptation, improved drenching, improvement of the drying phase through heat pump and combined wash&dry programme

¹² WD-C2 includes PM motor, improved load detection and adaptation, improved drenching, improvement of the drying phase through air condensing system and combined wash&dry programme

¹³ WD-C1 includes PM motor, improved load detection and adaptation, improved drenching, improvement of the drying phase through design of combined wash&dry programme

¹⁴ WD-C5 includes PM motor, improved load detection and adaptation, improved drenching, automatic detergent dosage and consumer feedback on loading, improvement of the drying phase through air condensing and combined wash&dry programme

- Benefits would increase if the laundry process were carried-out with higher loads. The consumer feedback mechanism on loading aims at encouraging users to increase loading. (WD-C4, WD-C5, WD-C6).

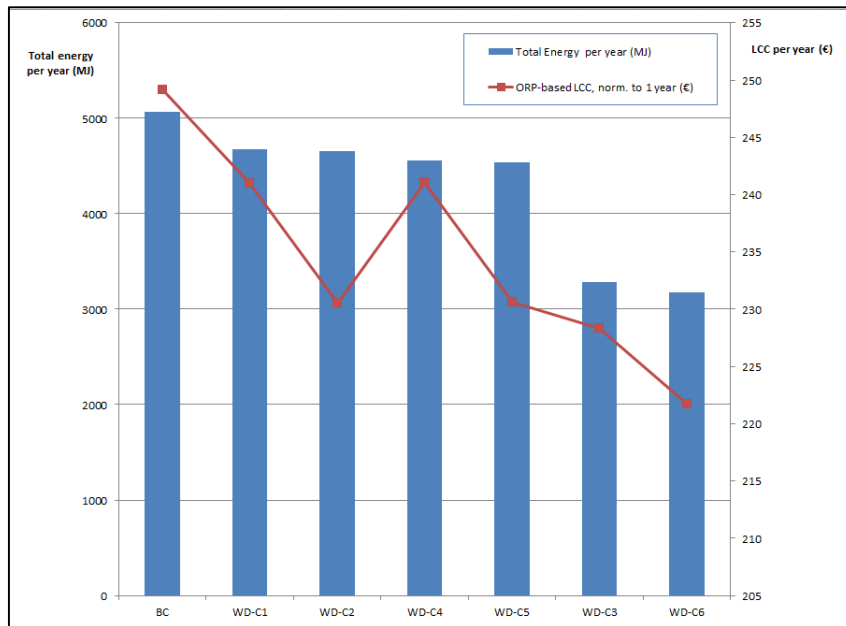


Figure 17: Primary energy consumption vs. LCC of combinations of improvement options selected for WD

Finally, comparing the conclusion drawn for the assessment of the design option of washing machines and washer dryers, the use of a heat-pump for the washing process increases the LCCs and only permits more limited energy savings in the wash cycle, compared to its application to the drying process per se. The **parallel implementation** of heat pump technologies to **both the washing and the drying processes** is an option that could be developed in the future.

3.1.5. Resource efficiency aspects

With regard to resource efficiency considerations for household washing machines and washer-dryers, the results of the review study revealed the following findings.

- The average expected product lifetime of washing machines and washer-dryers (i.e. first useful service life of a machine replaced due to a defect) of 12.5 years has slightly decreased compared to the typical former value of approximately 15 years. However, washing machines and washer-dryers are still relatively long-lasting products compared to other electric and electronic equipment (EEE). In addition, attention should be drawn to an increasing portion of consumers who are tending to replace still functioning appliances in order to have a better device.. Prakash et al. 2016 have shown via consumer research in Germany that over 10 % of replaced large household

¹⁵ WD-C4 includes PM motor, improved load detection and adaptation, improved drenching, automatic detergent dosage and consumer feedback on loading, improvement of the drying phase through design of combined wash&dry programme

appliances were still functional, and were replaced solely due to consumers' wishes to own a better device.

- The same study shows that there has been an increase in the proportion of household washing machines that have to be replaced earlier than their expected-average lifetime because of an appliance defect, especially within the first 5 years.
- It is difficult to assign reasons for breakdowns to common components in washing machines and washer-dryers. The causes of breakdowns vary, stemming from sources such as the motor, electronics, shock absorbers, heating elements, drainage pumps and door hinges.
- For household washing machines, the use pattern or, at times, misuse of the appliance by consumers might lead device defects to appear earlier, e.g.:
 - overdosage of detergent may block the detergent hose and the drain system
 - over time, the presence of foreign objects in the drain pump filter may block the pumps
 - use of the washing machine without proper horizontal levelling, i.e., using a spirit level, may lead to the early wearing out of shock absorbers and bearings
 - incorrect loading leads to imbalance, and wears out the shock absorbers and ruins the bearings
 - hot water washing cycles may cause blockages in the water outlet
 - keeping the door closed between washing cycles can cause the growth of mould (in particular in the door seal)
 - lack of proper maintenance by the users (e.g. cleaning of the filters and decalcification)
- Reparability of washing machines 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 washing machines and washer-dryers has become less attractive to consumers due to the relatively high costs of repair (estimated to be between 100-300€ depending on the defective component, and the country where the repair takes place). Where a defect occurs, appliances are increasingly discarded, even though repairing them might have increased the products' lifetimes. Reasons for not repairing a device are also related to the relatively high costs of repair compared to the relatively low price of purchasing a new appliance (approximately 415€ for a WM, and 830€ for a WD).
- In addition to the above issues, Tecchio et al. (2016) collected data on the early replacement of household washing machines, when consumers mistakenly believed the appliance to be defective. The study reported that approximately 6.7% 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 failures in parts related to electronics (14% of cases), shock absorbers and bearings (13.8%), doors (11.5%), carbon brushes (9.7%) and pumps (7.5%).
- Regarding end of life (EoL) management, both washing machines and washer-dryers are subject to established recycling processes in accredited Waste Electrical and Electronic Equipment (WEEE) installations. Appliances (especially WDs) with heat pumps should be processed separately for depollution (extraction and incineration) of the fluorinated gases ("F-gas") refrigerants. Permanent magnet motors in washing machines and washer-dryers 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.

- Some Member States (e.g. IT, ES, PT, GR) have low collection rates of waste washing machines and washer-dryers through the accredited WEEE collection systems, mostly in connection with producer responsibility systems. Based on those countries' national statistics, only around 1/3 of the appliances sold on their markets are treated in accredited installations. In other Member States, this share is around 2/3 (i.e., double the above share). In both cases, there are significant waste flows that are apparently not treated following WEEE prescriptions. The fate of appliances that are not collected and registered in the official statistics (2/3 for the aforementioned group of MS and 1/3 for the other MS) might be due to different causes, such as prolonged storage in households, recycling within the EU but in non-accredited installations that do not report to official Member State statistics bodies, or due to export as used EEE or end-of-life equipment to non-European destinations. The revised WEEE Directive has set specific measures to try to overcome this problem, and to address measures for these waste flows. Under the Action Plan for a Circular Economy, the Commission also looks at how to improve producer responsibility systems by, for example, using minimum operation rules (e.g. transparency of fees and costs, non-profitability) and using fees for manufacturers based on the recyclability of their appliances (for which clear definitions and measurement of recyclability will be needed).

Based on an analysis of this background, Ecodesign requirements for material efficiency and EoL-management of household washing machines and washer-dryers have been proposed.

3.1.6. Summary of the revision

The review shows that further improvement potential for the energy efficiency of household washing machines and household washer dryers is possible and that resource efficiency requirements are important. Higher improvement potential for the energy efficiency of household washing machines and household washer-dryers could be realised if consumers were persuaded to use the most-efficient programmes whenever possible and if loading was increased.

The review study made a number of recommendations on ecodesign and energy label requirements that could be introduced or modified for washing machines and washer-dryers. 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.

The main results of the review study are the following:

- Energy label classes: Most washing machines already exceed the highest current energy efficiency class, A+++ . This is especially true for appliances with higher rated capacities and heat pump-equipped washing machines, or washing machines with very advanced technologies. A re-scaling of the energy labelling classes should therefore simplify comparisons for consumers and provide an incentive to manufacturers to continue improving their appliances.
- Range of programmes: Washing machines are characterised by a broad range of programmes, besides the standard cotton 40°C/60°C programmes that provide the basis for measuring the energy consumption of the appliance and the EU Energy Label classification. Usually, non-standard programmes are not, however, optimised regarding energy efficiency to the same extent as the standard programmes. This contrasts with the findings of a user survey undertaken in 2015, which indicated that 90% of respondents expect or understand the label to represent the performance of the washing machine in all programmes, not only in some of them.
- Use of standard programmes: Especially for washing machines, the standard cotton 40°C/60°C programmes are actually used only to a minor extent (17% altogether, or 5% if considering only the programmes lasting more than 3 hours). There are other programmes for the same purpose (i.e. the 'normal' cotton 40°C/60°C programmes) which are used more often (26% altogether)

which consume more energy and water than the standard programmes. In some appliances, consumers can also change the characteristics of the standard cotton 40°C/60°C programmes by adding options such as 'short' or different temperatures. Such alterations tend to increase the energy and/or water consumption of the standard programmes.

- Programme duration: The standard cotton 40°C/60°C programme, whose combined energy consumption is displayed on the EU Energy Label, and thus influences the purchase decisions of consumers, were designed to improve energy efficiency. However, this reduction in energy use is often achieved via - in parallel - reducing the washing temperature, and prolonging the programme duration, as trade-offs to maintain the washing performance. However, these characteristics are not so convenient to consumers, and contradict their usual preferences.. The above-referenced 2015 user survey indicated that most consumers accept a maximum of 2-3 hours'programme duration, and there is a clear reluctance to use programmes lasting over 3 hours.
- Loading of machines: In general, consumer research shows that the average amount of load in actual conditions of use is around 3.4 kg per cycle for the cotton programmes. This load is much lower than full load, and is substantially lower even than the average 5 kg load used for measurement under standard conditions for a 7kg capacity machine. In parallel, the market seems to be moving towards an increase of the rated load capacities of machines. The current calculation of the Energy Efficiency Index (EEI) makes it relatively easier for large machines to reach a good EU Energy Label rating. However, the lower consumption values per kg of laundry are only obtained if machines are fully loaded, which is generally not the case in real-use conditions. Corrective actions should aim at improving the loading of the machines, as it is one key aspect to increase their energy efficiency. According to the review study, even relatively small increases of load (e.g. 4%-8%) would be beneficial for the overall performance of the machines.
- Technical innovation: the results from the review show that further energy savings for washing machines could be achieved by technical improvement in the following features: adoption of permanent magnet motors, improved drenching, improved load detection and partial load adaptation, automatic detergent dosage and consumer feedback on loading. These options have minimal impacts on life cycle costs. The use of a heat pump, or very advanced technology features, leads to energy savings, but these savings do not make up for the initial investment cost over the lifetime of the appliance. For washer-dryers, further improvement in the technical design includes options such as the use of permanent magnet motors, improved load detection and adaptation, improved drenching, automatic detergent dosage, consumer feedback on loading and improvement of the drying phase via air condensing or design of the combined wash&dry programme. These options barely influence the life cycle cost. The use of a heat pump for improving the drying process represents a significant investment cost but it also leads to significant energy savings; therefore, it can be considered a suitable technology option for washer-dryer appliances.
- Durability: Statistics point to an increased proportion of household washing machines that have to be replaced earlier than the expected average lifetime, especially within the first 5 years, due to a defect. Early device defects may be due in part to consumer behaviour.

The main results of the review study regarding the other aspects required to be revised by Article 7 of Regulation 1015/2010 are the following:

- Rinsing performance: standard EN60456:2011 describes a procedure for measuring rinsing efficiency by measuring alkalinity. This method was not considered sufficiently reproducible, resulting in difficulties to compare rinsing efficiencies or to set minimum requirements. An alternative measurement method for rinsing performance is under development, but at the time of writing it has not yet been finalised.
- Spin-drying efficiency: The spin-drying efficiency influences the residual moisture content of the laundry, which ultimately decreases the energy demand of the subsequent drying process, but

also the energy demand of the subsequent ironing process. Given the different programmes and user needs in terms of drying and spinning, the complexity of assessing possible trade-offs with line-drying and ironing, and the market transformation observed (most of the appliances on the market achieve a dry-spinning efficiency class between C and A), it is proposed to keep the current overall framework but to adapt the scale to the newly proposed testing portfolio and to only communicate this information via the QR code (accessing to the information product sheet) on the Energy Label. Ecodesign minimum requirements on spin-drying will not be set. In addition, it was observed that most of the appliances on the market achieve a dry-spinning efficiency class between C and A already (plus, many machines offer the possibility for customers to change this performance level).

- **Hot water inlet:** the use of hot water inlets could lead to additional energy savings if the optimal conditions are met (e.g. short and well-insulated pipelines, high efficiency water boilers providing the alternative source of hot water, provision of renewable energy sources to heat the water, etc). However, given the variety of installations and boilers used in houses and the complexity of assessing possible trade-offs, it does not seem advisable to set stronger requirements at this stage. On the other hand, information requirements are considered to be suitable to promote the use of this machines wherever and whenever they can bring environmental benefits. The market share of appliances that are compatible with hot water inlets is currently very low, although some increase is expected in the near future in relation to the installations of renewable energy technologies in the residential sector, as supported by Art 13(4) of Directive 2009/28/EC.
- **Verification tolerances:** the current tolerances (10% for single tests and 6% for 3 appliances tests) seem appropriate with regard to stakeholder feedback received. However, the review study does propose changes in the testing portfolio, which will need the recalibration of the verification tolerances by means of round robin tests done among different laboratories.

The review study made a number of other recommendations on Ecodesign and EU Energy Label requirements that could be introduced or modified for washing machines and washer-dryers, based on the technical, market and economic analysis that were carried out, These recommendations also aim to address market failures, and thus to improve overall environmental performance during the life cycle by :

- having requirements which facilitate repair (e.g. provisions and design for easy repair)
- stipulating requirements which facilitate recycling and depollution actions at the end-of-life of the appliance (e.g. design for dismantling for depollution purpose and recovery and recycling)

3.2. Policy scenarios for washing machines

Based on the results of the review study, the goal of the current revision is to revisit whether the technical design options, based on Ecodesign (ED) and Energy Label (EL) requirements, can facilitate the realisation of the saving potential of more efficient technologies and increase the use and loading of energy efficient washing programmes. In this sense, for household washing machines, the following policy scenarios have been investigated during the review study.

Table 2: Comparison of possible policy scenarios for household washing machines

Scenario	Sub-scenario	Comments
0. BAU	0. BAU	Reference Scenario based on actual use conditions with no implementation of further policy instruments or changes/modifications in the current ones
1. ECODESIGN	1.a 40°C cotton as testing programme	Only a 40°C cotton programme is used for testing. The testing 40°C cotton programme is optimized and preferred by consumers
	1.b Time cap	Introduce a time cap of 180 min for the testing programmes. Consumers are expected to increase the use of this programme. NB This will increase the energy consumption of the testing programme.

Scenario	Sub-scenario	Comments
	1.c Merging standard programmes	The testing programmes are merged into a single programme. Consumers choose the single programme more frequently
	1.d Additional lightly soiled programme	An additional programme is obligatory in all machines for lightly soiled laundry. Consumers are expected to choose this programme regularly
2. ENERGY LABEL? YES or NO	2.a Only Ecodesign	Only Ecodesign requirements are proposed, with the minimum energy performance requirements becoming stricter than current stipulations
	2.b.1 Ecodesign and Energy Label – Class A and B are empty	Both Ecodesign and Energy label are implemented. Ecodesign energy requirements are close to those currently specified, but the Energy Label is re-scaled. The best energy performing machine at the time of re-scaling is placed in class C
	2.b.2 Ecodesign and Energy Label – Class A is empty	Both Ecodesign and Energy label are implemented. Ecodesign energy requirements are close to current ones, but the Energy Label is re-scaled. The best energy performing machine after re-scaling is placed in class B
	2.b.3 Ecodesign and Energy Label – Best HP-WM in class A	Both Ecodesign and Energy label are implemented. Ecodesign energy requirements are close to the current ones but the Energy Label is re-scaled. The best energy performing machine at the time of re-scaling is placed in class A
3. DURABILITY	3.a Increase in the expected lifetime of the machines	The expected lifetime of the washing machines is supposed to increase by 2.5 years from 12,5 years to 15 years
	3.b Increase in repaired machines	The share of machines that are successfully repaired increases from 30% to 50%
	3.c Increase in reused machines	The share of machines that are reused increases from 8% to 18%

3.2.1. Scenario 0: Business as Usual (BAU)

The definition of the Business as Usual (BAU) scenario for washing machines 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 development of the energy consumption of the washing machines over time (see Section 3.1.2.1), it could be assumed that a “plateau” is going to be reached soon. Because improving energy efficiency might come at a higher cost, it is expected that it would not be implemented as quickly as in the other scenarios. Thus, in this scenario it is assumed that there are little additional energy efficiency improvements. As the Energy Label would lose its potential for consumers being able to differentiate among washing machines, manufacturers will have little incentive to go beyond the current energy label class A+++, except for advertising claims such as e.g. “20% more efficient than the A+++ class”. However, these claims would be difficult to verify, as they are not bound by legal rules. In addition, the wording and the framework of such advertisements is confusing. A gradual shift to populate only the A+++ class could be expected.

3.2.2. Scenario 1: Modifications of the testing standard for measurement to become more representative to actual consumer programmes use

This scenario analyses the option of changing the standard for measuring and determining the EU Energy Label classes in a way that becomes more representative to the actual washing machine programmes that consumers use. Machines are optimised for the programmes that are the basis of the standard measure. The testing programmes should represent the actual use of programmes by the consumer and therefore should be based on the most frequently used programme(s), or a combination thereof. This scenario does not analyse other type of changes to the EU Energy Label.

This scenario assesses four possible changes to the current standard for testing:

- **Scenario 1a:** 40°C cotton programme as the only testing programme. This scenario assumes that for the calculation of the energy consumption and other performance parameters of household washing

machines, the programme which cleans normally-soiled cotton laundry at 40°C is used. Importantly, this programme corresponds to the current 'normal 40°C cotton programme' and *not* to the 'standard 40°C cotton programme'. Scenario 1a instead selects the most-used programme by consumers to become the testing programme, and considers that the current 'normal 40°C cotton programme' will be further technically optimised in terms of energy consumption without a significant increase of its duration.

- **Scenario 1b:** Time limitation for the current standard programmes: This scenario considers introducing additional requirements with regard to the duration (a time cap of 180 min), temperature, load and/or performance of the current standard programmes. This scenario is expected to lead to an increase in the use of the 'standard cotton programmes; which will therefore take some of the proportion of consumers' use of the "normal cotton programmes", although the two types of cotton programmes would be allowed to coexist.

- **Scenario 1c:** Merging standard programmes and improved programme identification: This scenario assumes that only one standard programme is offered. This standard programme is able to wash normally soiled cotton laundry declared on the textile label to be washable at 40°C and/or 60°C together in the same cycle because a temperature cap at 40°C is introduced. The scenario also assumes that consumers will combine normally-soiled 40°C and 60°C cotton loads in higher average loadings. The higher average loading is due to the improved identification of the programme that makes it easier for consumers to understand that laundry labelled as washable at 40°C and at 60°C can be combined.

- **Scenario 1d:** Additional programme for lightly-soiled laundry: This scenario is an extension of scenario 1c where the programme portfolio is complemented with a shorter cycle for lightly-soiled cotton clothes with a maximum temperature of 30°C. This scenario assumes that consumers would be likely to change their behaviour if such a programme were to be offered, and would thus select this new programme when cleaning lightly-soiled cotton laundry declared to be washable at 30C, 40°C and/or 60°C, combining the laundry together in the same washing cycleand, therefore at high loads overall. This shorter washing cycle will also displace some of the other washing cycles regarding proportion of use.

3.2.3. Scenario 2: Ecodesign and revised scaling of the EU Energy Label

In this scenario two options are explored:

- Firstly, removal of the EU Energy Label, but implementation of Ecodesign requirements equally as ambitious as today's requirements, or even stricter minimum energy efficiency requirements. However, this would be without introducing any of the changes in the standard for the measure (assessed previously)

Secondly, to maintain both Ecodesign and Energy Labelling, *and* to also assess different sub-options (2b1, 2b2 and 2b3) the effects of varying the ambition of the requirements for the re-scaled label classes.

In the first option, most of the manufacturers would not be motivated to improve the washing machine design beyond the mandatory requirements since there would be no differentiation based on Energy Label efficiency classes. Most of the manufacturers could focus more on decreasing the costs, or also look in greater detail at other non-energy related parameters, such as better durability, reparability, internet connections, etc. Some manufacturers will continue to improve their products with respect to energy efficiency, and may communicate their improved energy efficiency levels to consumers by other means, but not via the recognised EU Energy Label (i.e distinct, separate publicity campaigns on the energy savings of their products)

In such a scenario, it is important to consider that currently the EU Energy Label displays not only energy performance characteristics, but also environmental and functional information such as water consumption, noise and rated capacity (laundry load). It will henceforth not be defined in which

standardised format – or how - this information would be shared with consumers, if the EU Energy Label were to be removed.

The second part of the scenario assesses the implementation of a revised energy label scale from A to G, together with the current Ecodesign Regulation. EU Energy Labelling is a mechanism to help consumers making an informed decision especially regarding the energy consumption of the machine. It serves to differentiate products and identify the best energy performing machines. In these scenarios, the label class differentiation is created with a full scale of seven energy classes ranging from A to G. The three sub-scenarios (2b1, 2b2 and 2b3) differ mainly regarding the ambition of the requirements for the EU Energy Label classes. Note that no other Ecodesign requirements on energy consumption are proposed in these options, and neither are the synergies considered that might be manifested via jointly implementing modifications on the standard for measuring and re-scaling the EU Energy Label. (NB Changes to resource efficiency measures under Ecodesign are modelled subsequently in scenario 3).

The label class thresholds for the three Energy Label class sub-scenarios are shown in Table 3. Figure 18 (below) shows a graphical depiction of how the label classes may move according to possible sales predictions up to 2030, for the revised labelling scenarios 2b1, 2b2 and 2b3.

Table 3: EU Energy Label class distribution without revision and three possible revisions of the Energy Label class corresponding to scenarios 2b1, 2b2 and 2b3.

Since 2011					Revision (kWh/a)						
Label class	EEI min	kWh/a	EEI max	kWh/a	Label class	Scenario 2b1		Scenario 2b2		Scenario 2b3	
						min	max	min	max	min	max
A+++			46	175	A		60		77		90
A++	46	175	52	198	B	60	78	77	95	90	105
A+	52	198	59	225	C	78	100	95	113	105	122
A	59	225	68	259	D	100	123	113	134	122	142
B	68	259	77	293	E	123	150	134	159	142	166
C	77	293	87	331	F	150	184	159	189	166	193
D	87	331			G	184	225	189	224	193	225

* The product performance ratings in the classes shaded in red are no longer allowed to be placed on the EU market because of already-implemented Ecodesign minimum requirements.

To better understand the implications of the different thresholds it is important to know the annual energy consumption values of the best available appliances currently on the market, which are shown in Table 4.

Table 4: Annual energy consumption of Best Available Technologies washing machines on the market in first quarter of 2017 (source Topten.ch)

	Declared values		Estimated values for 7kg WM	
	Rated Capacity	Annual energy consumption	Rated Capacity	Annual energy consumption
A+++ -50% (heat pump or other very advanced technology in the washing machine)	8 kg	97 kWh/year	7 kg	85 kWh/year
A+++ -40% (best WM without heat pump or the very advanced technology)	8 kg	116 kWh/year	7 kg	101 kWh/year
A+++ - 30%	8 Kg	137 kwh/year	7 Kg	120kwh/year

Scenario 2b3 would allow heat pump-equipped appliances or machines equipped with a very energy efficient technology¹⁶ (i.e. kWh/year = 85) in Energy Label class A from the start of the revision. This is in conflict with the aims of the 2017 revised Energy Labelling "framework" Regulation 2017/1369, in which it is stated that "*no products are expected to fall in energy class A at the moment of introduction of the label*". Some stakeholders may debate, however, if heat pump-equipped appliances or appliances equipped with very advanced technologies fulfil the requirement of being "a product on the market", as the sales figures for those appliances are currently very low (i.e. the market sales of the heat pump-equipped washing machines is estimated to be less than 2000 units per year, i.e., less than 0.08% of the total sales of washing machines in the EU). In addition, the high purchase price of these products (above 4000 Euros) would predict that they will remain as a niche-market product for some time to come. .

Scenario 2b1 allows heat pump-equipped or other very advanced technology-equipped appliances to solely populate Class C (Classes A and B remain strictly empty). Under Scenario 2b2, however, these advanced technologies are allowed to already populate Class B (i.e., solely Class A remains completely empty)..

For Scenario 2b1, the empty classes A and B are seen as classes to be populated over time in the future, once new innovation and possible improvement potentials have become exploited. For example, at the time of writing (September 2017), the research team had not identified in the review study any washing machines with a declared annual energy consumption of less than 85 kWh/year for a rated capacity of 7Kg. These figures would fulfil the necessary requirements of Scenario 2b1, i.e., Class A and Class B would initially be completely empty.

The motivation of manufacturers to develop machines with higher energy efficiency levels would tend to be higher under Scenario 2b2 than under the conditions of Scenario 2b1 (i.e., they would be rewarded by obtaining Class A sooner, under the imposed conditions of Scenario 2b2). In more detail, Scenario 2b2 shows an energy label class revision where the current heat pump or very advanced technology equipped washing machine would be placed in Class B. Given that this is the second revision of the Energy Label for washing machines, one could expect that further energy improvements would be more difficult to realise as there may be slower future technological progress gains for this product group. Hence, following this line of argumentation, it might be justified to keep solely Energy 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 (as shown in scenario 2b1) would in reality mean very little differentiation among the presently-available products, over the overall labelling A-G range. If we exclude from considerations heat pump/ other very advanced technology models, such an revised Energy Class regarding would result in the best current WM models (presently rated as "A+++ -40%") in Energy Label Class D, i.e., after the review.

Washing machines that currently reach A+++ would be mostly classified in class F after the review, and all other machines would fall into class G. It could be expected that under such circumstances the market might split into two "populations", namely one population equipped with heat pump or very advanced technologies (which are more complex and expensive), and a second grouping of (cheaper) washing machines, which do not have any of these advanced, more expensive technologies. It is also important to mention that those washing machines of the first group (with heat pump or very advanced technology equipped) will not necessarily always achieve the expected savings in practise, since as users may not select the "standard" programme, opting instead to use programmes in which those technologies -

¹⁶ At the time of writing this machine includes a device to mix the water and detergent before distribution in the clothes plus jet system for distribution of water and very high efficiency components, in particular PM motor. Additionally it has an extended time duration

although still present in the appliance - are not able to be fully exploited, owing to programme-related reasons such as time duration, or other functional aspects. The producers of the second group of washing machines without the heat pump or other advanced technologies would have little incentive to improve their products regarding energy efficiency, and thus they would remain as manufacturers of products with low- or middle-ranking products, from an Energy Label Class perspective. Manufacturers of this latter group of models might instead prefer to compete in terms of reducing costs (leading to reduced purchase prices) or via other developments, not linked to energy efficiency (e.g. interior and exterior design). Moreover, machines with a heat pump use more material and are more complex, and therefore come with a potentially higher rate of failure risk, and are possibly more difficult to repair.

The forecast evolution of the sales distribution in terms of energy efficiency classes between the years 2020-2030 for each of the scenarios 2a, 2b1, 2b2 and 2b3 are shown in Figure 18. It should be mentioned that it is difficult to estimate future sales distributions, and that such estimates have a big influence on the outcome of energy savings and other impacts.

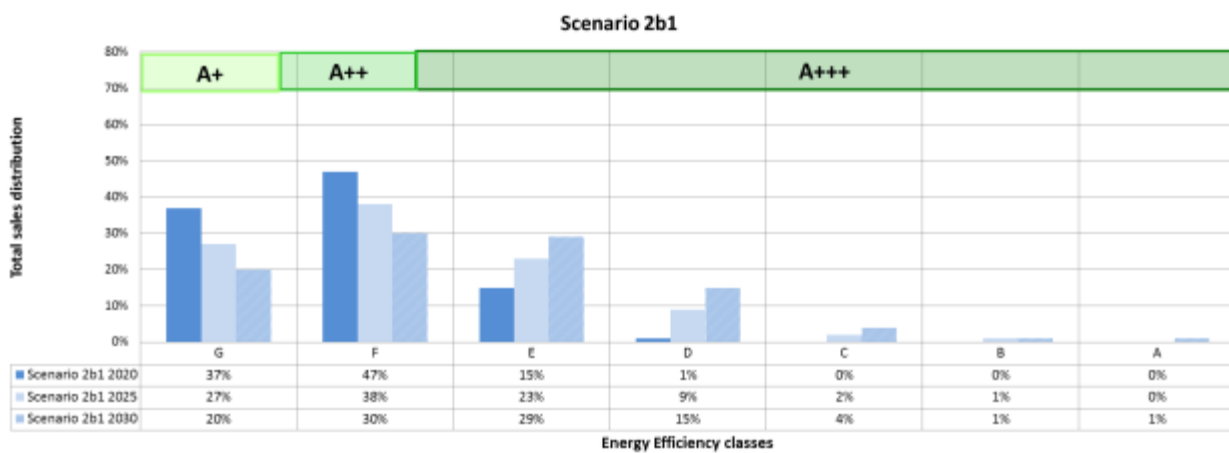




Figure 18: Estimated sales distribution for scenarios 2b1, 2b2 and 2b3

Given the current knowledge basis, for Scenario 2b1 it seems very difficult - if at all possible - for washing machines to reach a high revised Energy Label class (i.e., Class A or Class B) if they are not equipped with a heat pump or very advanced technology. Also, the current high purchase price of heat pump or very advanced technology equipped machines prevents a broad uptake of these products. In addition, a high proportion of washing machines without heat pump or very advanced technology would be classed E to G in the revised scheme, under Scenario 2b1. As such, this might result in the perception that those WM without heat pumps or very advanced technologies were, in general, of lower quality, with lower performance attributes. . Communication strategies to counter these impressions would be needed, aimed at reassuring consumers.

It might also be possible that another technology might be developed, that was able to compete in terms of energy efficiency, with the heat pump or very advanced technologies. However, presently is no indication of this. The present-day situation is that most manufacturers are hesitant to use the heat pump technology to make it a mainstream, since they perceive it solely to be a so-called "lighthouse" technology, sold to luxury niche consumers, without the need for any additional sales arguments.

3.2.4. Scenario 3: Durability/reparability

The assessment of the potential net environmental benefits when the durability (with or without repair) is improved needs to be assessed in a scenario that compares longer-lasting washing machines to conventional machines, for the same period of time. In this comparison, the newer machines that are replacing older ones are automatically considered to be more energy efficient. This comparison tries to

answer the question of whether an extension to the product lifetime will bring benefits. Tecchio et al 2016 have shown that, using the current stock and labelling regime, a washing machine has to be at least 28% more energy-efficient to serve as an 'efficient' voluntary replacement, i.e., not to replace a completely broken-down washing machine. In this study, preliminary estimations are made which could be further refined in the actual impact assessment.

The repair of performance failures in the washing machines will have an impact on the average time of a product in the European stock. The BAU scenario estimated that old in-service washing machines will be replaced by new ones after, on average, 11.86 years on the market (in-service time) and that the amount of machines that will display a failure during their lifetime will be approximately 70%. This scenario considers that 30% of the washing machines are repaired once in their lifetime, and that 8% of the machines that were discarded without a failure are likely to be reused.

The scenarios on durability/reparability will model possible extensions of the time an average WM remains in the stock (in-service) "population", either by manufacturing more robust machines (i.e. increasing the technical product lifetime, scenario 3a) or by increasing the number of machines that are repaired (scenario 3b) or reused (scenario 3c). The increase of the machines that can be repaired can be either due to measures that increase both the ease and the technical feasibility of a repair, and/or decreasing the cost of a repair. The extension of the in-service time of a washing machine will have an impact on the forecast sales (especially replacement sales), consumer expenditure, energy and water savings and all 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 provision 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.

Scenario 3a: Increasing the robustness of the machines

This scenario is modelled by assuming an increase in the expected lifetime of washing machines by 2.5 years, i.e. from 12.5 years to 15 years. This would shift the in-service time of an average washing machine from 11.86 years to 14.49 years. No other parameters, e.g. the purchase cost, are changed due to this assumption. The percentages of machines repaired (30%) or reused (8%) are maintained constant in this scenario.

Scenario 3b: Increasing the rate of machines repaired

This scenario is modelled by assuming an increase in the rate of repair from 30% to 50% for machines which have a failure. This scenario represents either a higher number of appliances that are sent to be repaired by the consumers or an increase in the ratio of those that are technically and economically successfully repaired. The original expected lifetime of 12.5 years and the ratio of 8% of machines being reused is maintained as constant in the model, together with all the other parameters. This would increase the in-service time overall by just over one year, from 11.86 years to 12.98 years.

Scenario 3c: Increasing the rate of machines being reused

This scenario is modelled by assuming an increase in the rate of machines that are reused when discarded without failure, i.e. from 8% to 18%. The reused of discarded washing machines without failure can be realized i.e. in a second hand market. The original expected lifetime of 12.5 years and the rate of 30% of machines being repaired are kept constant, together with all the other parameters. Since the machines that are considered to be reused are only a small portion of those machines that would be discarded without any failure and replaced by new machines, the overall effect of the increase in the rate of machines that are reused is much diluted. In this sense, the time in-service of the washing machines hardly changes and an average washing machine will stay around 11.88 years in the stock of European washing machines.

Table 5: Parameters changed in comparison to the BAU scenario for each of the scenarios 3a, 3b and 3c

Scenario	Measure	Expected lifetime (years)	% of repairs	% reused machines without failure	Average in-service time (years)
BAU/2a	-	12.5	30 %	8 %	11.86
3a. Durability	Increase in the expected lifetime	15	30 %	8 %	14.49
3b. Reparability	Increase % of repairs	12.5	50 %	8 %	12.98
3c. Reuse	Increase % of reused machines without failure	12.5	30 %	18 %	11.88

3.3. Environmental significance of the proposed policy scenarios for washing machines

Note that a formal Impact Assessment (IA) will be undertaken after the Consultation Forum (CF). The following figures result from the review study and are indicative until the formal IA.

The different scenarios act differently on the evolution of resource consumption (energy and water) in the EU28.

The expected energy and water consumption of the **scenarios** for an average washing machine (a washing machine of 7 kg rated capacity) in the period 2015-2030 are displayed in Figure 19 and Figure 20, respectively. For all scenarios the individual energy and water consumption of a unit decreases over time.

Estimated Future Energy Savings

Figure 19 shows that the maximum energy saving is expected for Scenario 1d, with an energy saving of 15.01 kWh per WM/year in 2030 (which represents approx. 3.54 TWh/year for the estimated total EU washing machine stock, at EU28 level). This is a saving of c. 12 % of the energy consumption in the BAU scenario estimated in 2030. For comparison, 3.54 TWh represents 0.5 % of the total EU28 electricity consumption of private households in 2014 (i.e., 67.5Mtonnes of oil equivalent [Mtoe], i.e., c. 785 GWh). Note that Scenario 1d assumes an important change in user behaviour, since in this scenario consumers use an ECO light programme that is only suitable for lightly-soiled laundry (while standard programmes are designed to wash normally-soiled laundry). Scenario 1d also assumes that consumers will increase the average loading in each wash cycle.

The second best options are Scenario 1b and Scenario 1c. These scenarios estimate, respectively, future energy savings of 4.45 kWh per WM per year and 4.11 kWh per WM per year, in the year 2030 (for the EU28 total stock of washing machines this represents, respectively, approx. 1.05 TWh/year and 0.95 TWh/year of the EU washing machine stock at EU28 level), being about 4% and 3% of the energy consumption in the BAU scenario estimated in the year 2030. This scenario relies on restricting the other cotton 40°C programmes, and includes some restrictions regarding time and temperature regarding the standard programme.

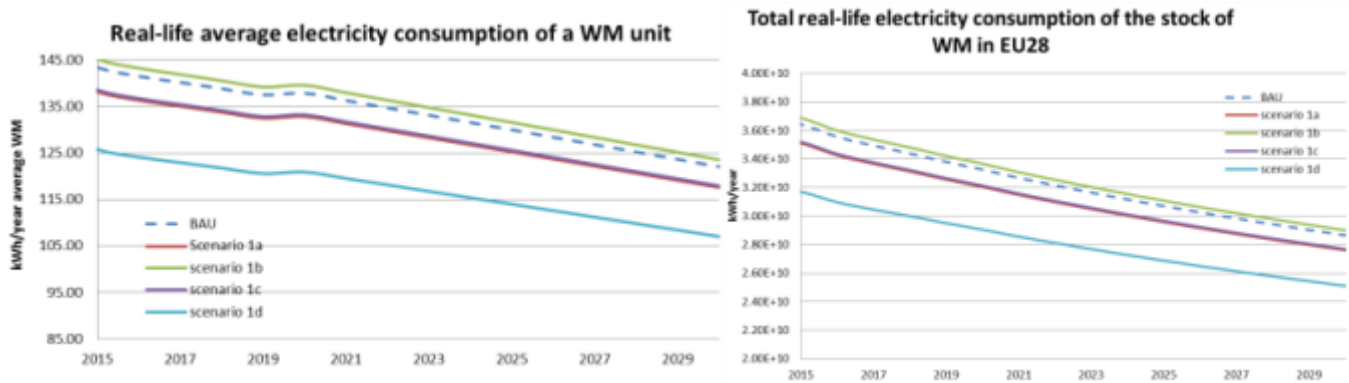


Figure 19: Estimated average electricity consumption under real-life conditions (or actual use conditions) of a WM unit and total electricity consumption of the stock of WM in EU28 for scenarios 1a, 1b, 1c and 1d

Estimated Future Water Consumption Savings

A maximum water saving of 23.2 litres/year per average WM unit is expected in 2030 for Scenario 1c, being around 2% of the water consumption in the BAU scenario. The second best result is obtained by Scenario 1a (resulting in water savings that are also c. 2% of the BAU scenario in the year 2030).

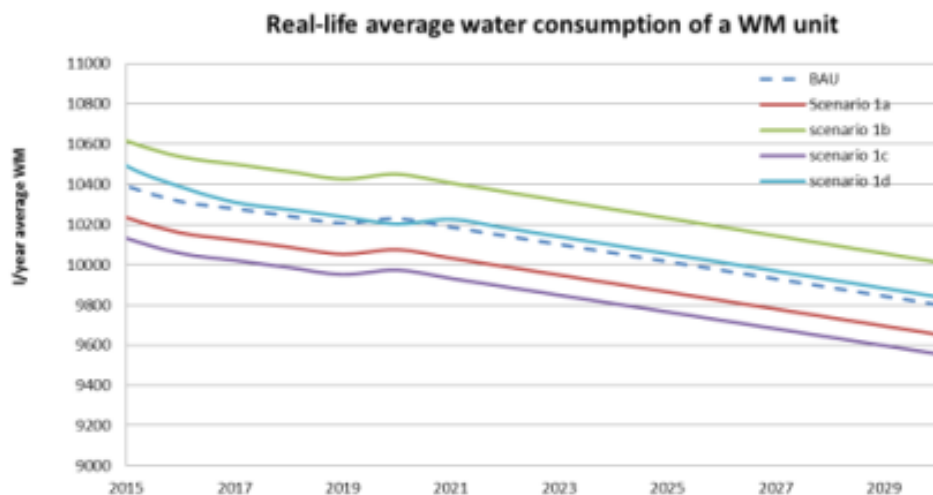


Figure 20: Estimated water consumption under real-life conditions of a WM unit for scenarios 1a, 1b, 1c and 1d

Estimated Future Consumer expenditure

With regard to total consumer expenditure, all the options of scenario 1 show an increasing trend. This is because utilities prices, and to a much lesser extent, the stock numbers of washing machines in the EU28, are expected to increase in the coming years (as shown in the Figure 21). The overall consumer expenditure will increase during the WM use, since the reduction in costs due to the predicted energy savings will not be sufficient to compensate for the expected extra costs due to increasing prices of utilities costs/ kWh and per litre of water used. The different energy and water consumptions of each of the options trigger the differences among them, resulting in a maximum saving of around 751 million Euros₂₀₁₅ per year for Scenario 1d in the year 2030, and 212 million Euros₂₀₁₅/year (scenario 1a) and 216 million Euros₂₀₁₅/year (scenario 1c) for and per year in the year 2030, by comparison to the BAU scenario.

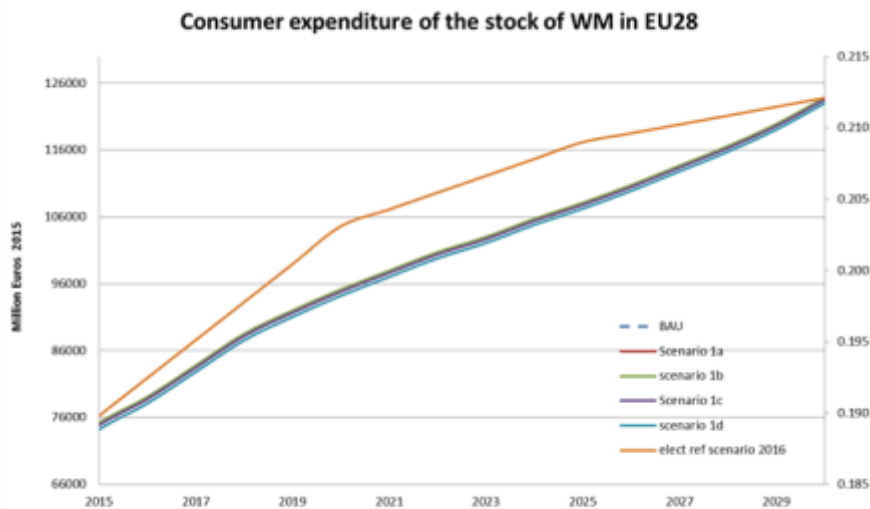


Figure 21: Estimate consumer expenditure for the washing machine stock in EU28 compared to the BAU scenario for scenarios 1a, 1b, 1c and 1d

The impacts in terms of expected job creation in the EU28 in 2030 are expected to be the same as for the BAU scenario, since the distributions of sales regarding the energy efficiency labels are not changed.

Stakeholder feedback on the options of different sub-options of Scenario 1 has been abundant, but a clear consensus for one specific option has not been reached. The two most widely-supported options were scenario 1a and scenario 1c, although some concerns were expressed, as described in the review study.

Stakeholders highlighted that scenario 1a, which based the standard programme on the most used programmes, will result, as a consequence of this selection, in an improvement of this programme that will become as efficient as possible. To realise this requirement, the duration of the normal cotton 40°C programme could be extended, and the wash could be performed at lower temperatures than currently used. The use of this normal programme could increase significantly, provided that its duration is time-limited (e.g. to a maximum of 3h), and if the duplication of parallel programmes is avoided.

Regarding scenario 1c most stakeholders supported the notions that it approaches more closely real-life use patterns of washing machines, and that this scenario has huge energy saving potentials under actual use conditions, provided that wash cycles are short enough and provided a sufficiently high washing performance to consumers. Additionally, stakeholders highlighted that the success of this scenario depends on consumers' willingness to accept washing clothes with different care labels in only one programme (without necessarily a temperature indication). Other comments on this scenario could not

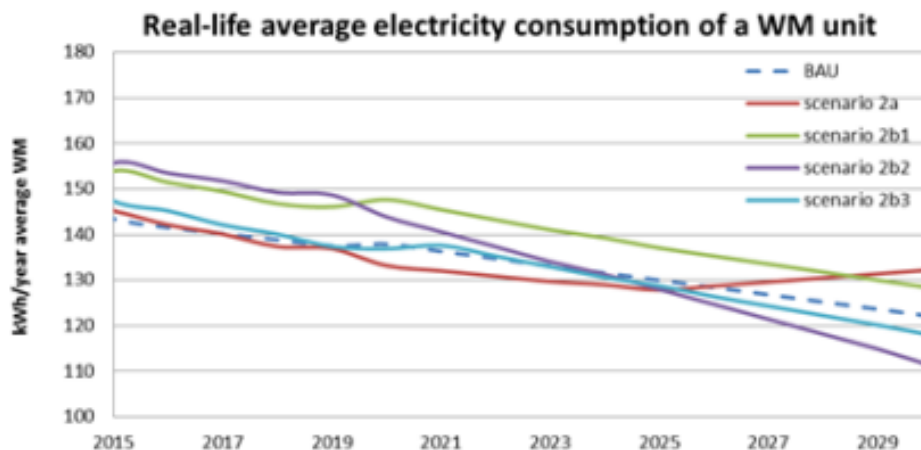
agree on the following aspects: the use of the name "ECO" or "ECO light"; the maximum duration of the ECO or ECO light programmes; whether additional eco-design requirements on the maximum energy consumption of the normal cotton 60°C programme might be needed via a time cap. These comments can clearly be applied to scenario 1d, which offered the best energy savings in scenario 1, from the modelling performed.

The outcomes of overall different sub-options of **scenario 2**, assessing the effectiveness and impacts of the Energy Label on the evolution of resource consumption (energy and water) are shown in Figure 22 and Figure 23. For all scenarios, the overall energy and water consumption of washing machines in the EU 28 is expected to decrease between 2015 and 2030. This is due to the combined effect of more efficient machines and a saturated market in which the number of unit remains approximately stable.

Figure 22 shows that the maximum energy saving is expected for scenario 2b3 and scenario 2b2, both scenarios having an energy saving of 0.69 TWh/year and 0.62 TWh/year in 2030, respectively (approx. 2% of the energy consumption of washing machines in the BAU scenario). Maximum water savings of 52 million m³ per year in the year 2030 is expected for scenario 2b2 (4% of the water consumption of the BAU scenario).

Note that scenario 2b1 is not the most efficient of the options, even though intuitively this would be expected, since it poses the strictest requirements. This counter-intuitive observation is due to the assumptions made in the distribution of the sales of the appliances in the future. The penetration of appliances into higher energy efficiency classes does not occur as fast as in other options of scenario 2, due to the larger energy performance bracket allowed within each Energy Label class. However, this scenario brings additional benefits and is the only one that fully complies with the requirements of the Energy Label Framework Regulation.

Scenario 2a shows the least promising results.. This indicates that the implementation of a revised Energy Label tool into the market still has potential to save resources in the coming years. However, the less promising results of scenario 2a are due to the assumption made in the distribution of the appliances that split them into two big groups: firstly highly-efficient machines, and secondly, machines falling in the lowest energy efficiency classes.



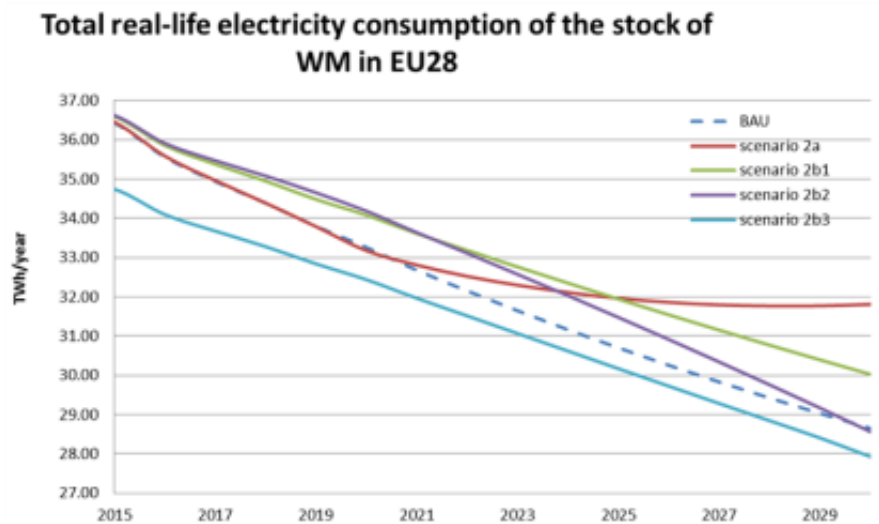


Figure 22: Estimated average electricity consumption under real-life conditions of the stock of WM in EU28 for scenarios 2a, 2b1, 2b2 and 2b3

The maximum water saving of 52 million m³ per year is expected in 2030 for scenario 2b2. This amount is approximately 4% of the overall water consumption due to the use of WM expected in 2030, in the BAU scenario for WM in the EU28.

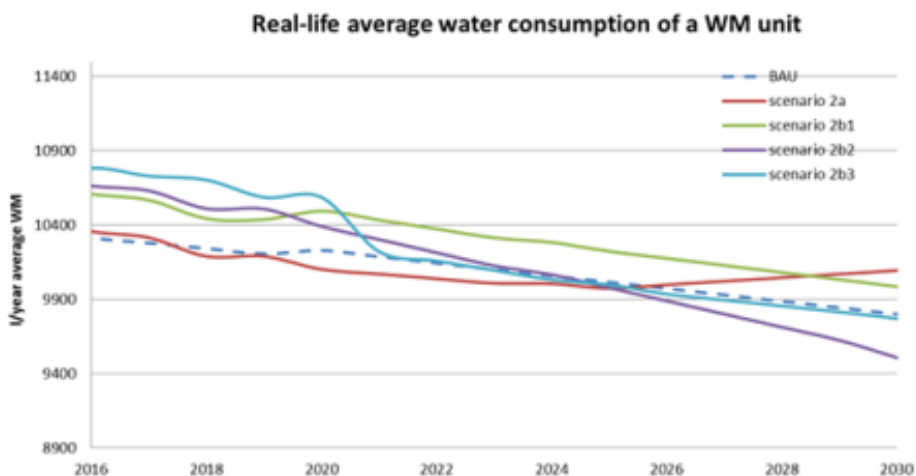


Figure 23: Estimated water consumption under real-life conditions of a WM unit for scenarios 2a, 2b1, 2b2 and 2b3

The total consumer expenditure for all options of scenario 2 shows a similar increasing trend (see Figure 24). This is because in the coming years not only the purchase price of the machines but also the energy and water prices are expected to increase. Repair and maintenance costs are the same in all scenarios. Finally, the impacts in terms of expected job creation in the EU 28 is stable for scenario 2 and is shown in Figure 25

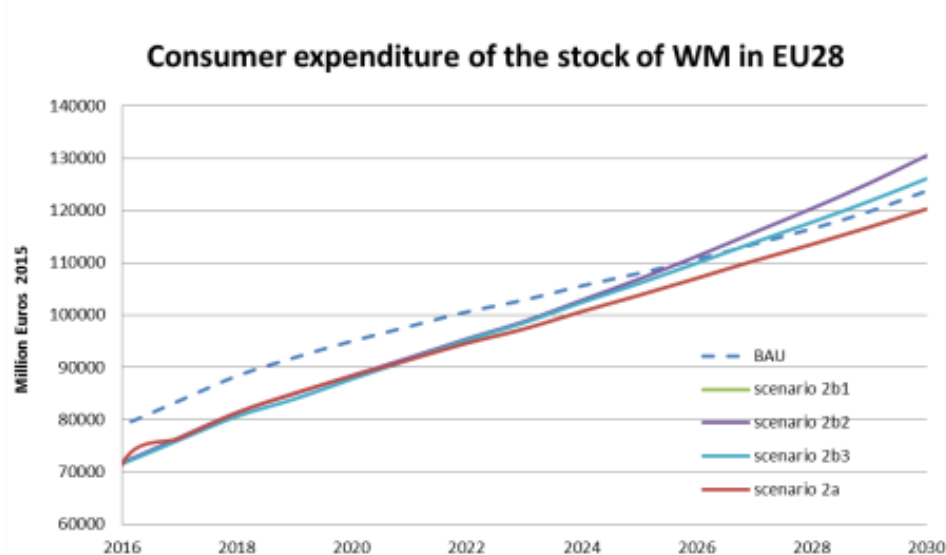


Figure 24: Estimated consumer expenditure over the lifetime of the washing machine stock in EU28 compared to the BAU scenario, for scenarios 2a, 2b1, 2b2 and 2b3

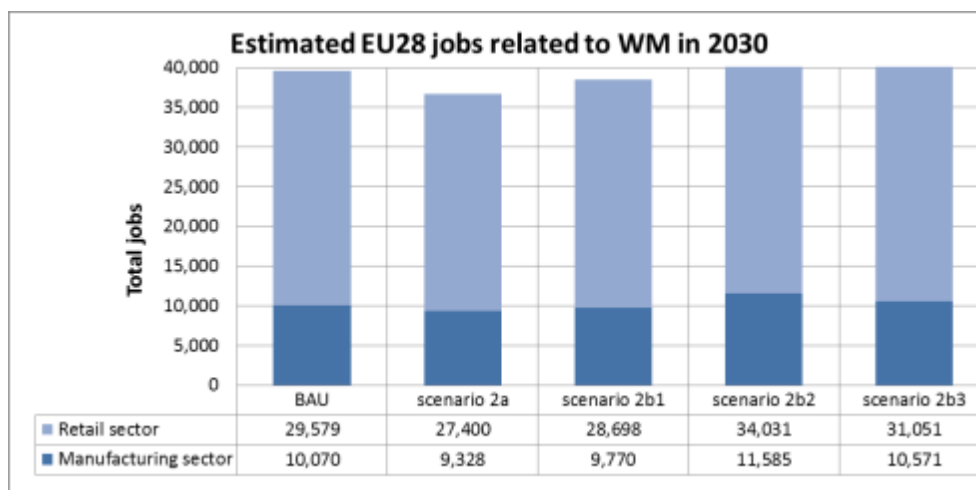


Figure 25: Estimated number of jobs by 2030 in the washing machine sector (manufacturing and retail) in EU 28 under the conditions of the BAU scenario and scenarios 2a, 2b1, 2b2 and 2b3

The total electricity consumption for the different options of **scenario 3** is shown in Figure 26. It shows that none of the modelled Scenarios 3a, 3b or 3c significantly affects the total electricity consumption under real-life conditions. Therefore none of the sub-options within scenario 3 have a relevant additional potential for electricity savings, nor do they have negative effects on energy consumption. However, from an LCA perspective, other contributions could be theoretically accounted for, e.g., the energy demand and the embodied GHG emissions related to the materials used for the manufacture of WM products. Thus, from measures promoting a higher resource efficiency of household washing machines, additional benefits can be expected.

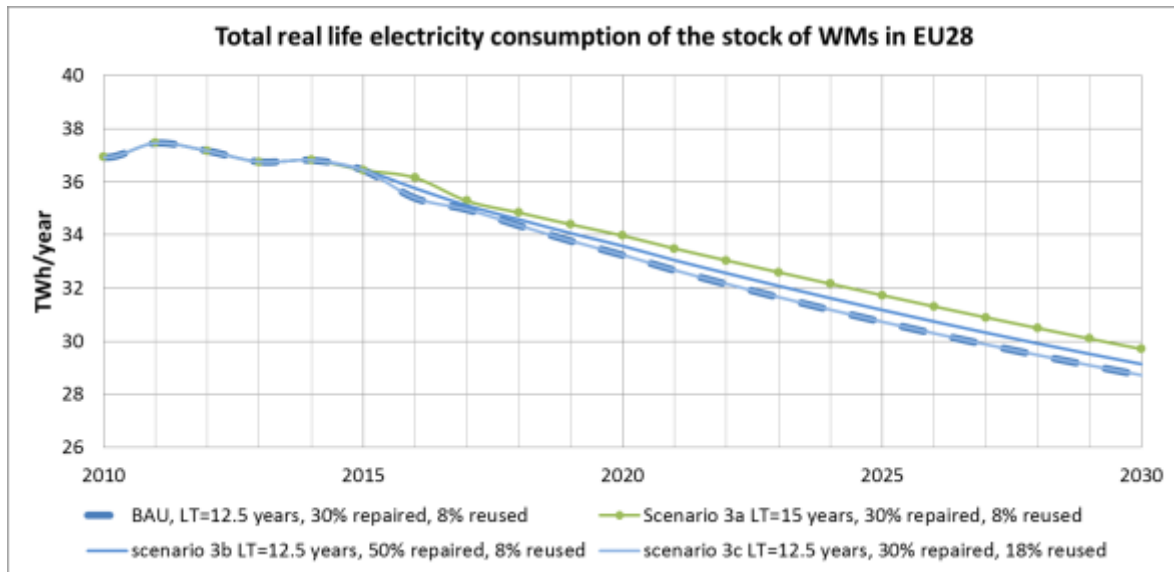


Figure 26: Estimated real-life water consumption of a WM unit for scenarios 3a, 3b, 3c and BAU

A prolongation of the service lifetime of washing machines 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 washing machines 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 repairable products. Such R&D shifts would assist the market penetration of the above potentially redefined commercial strategy.

3.4. Policy scenarios for washer dryers

Based on the results of the review study as summarised above, the goal of this section is to explore if appropriate Ecodesign (ED) and EU Energy Label (EL) requirements can capture and move the EU washer-dryer market towards more efficient technologies. For washer-dryers the following policy scenarios as noted in Table 6 have been investigated in the review study. Note that scenarios regarding their durability /reparability have not been investigated; it is assumed that the initial assessment derived from scenario 3 for washing machines can be directly applied to this product.

Table 6: Comparison of possible policy scenarios for household washer-dryers

Scenario	Sub-scenario	Comments
Scenario 4	4a WD split	Maintains current standard measuring at washing rated capacity, but follows the changes proposed for WM re. testing the washing process

Scenario	Sub-scenario	Comments
Standardisation	4b WD Remove	Maintains current standard for measuring, but the drying process is tested at the drying rated capacity. Some laundry has to be removed in-between the processes
	4c WD Combi continuous	A continuous wash&dry process is used for testing. It reflects the main feature of the WD, but not all WDs are equipped with this function
	4d WD Combi interrupted	An interrupted wasf&dry process is used for testing. Laundry is taken out of the WD, stored and reloaded within 30 min between the processes.
Scenario 5a Ecodesign requirements	Washing performance	Most of the models of washer-dryers have already achieved a washing performance Class A. This requirement will not affect the EU market.
	MER ¹⁷ drying process	MER for drying process will affect in a similar way that the MER for the wash&dry process. Data and conclusions drawn for that model will be considered for this scenario too.
	5a. MER wash&dry process	MER for wash&dry process will prevent those products with excessive energy consumption from entering into the EU market. Ecodesign tiers proposed to become progressively stricter to ban the entrance to the EU market to the today's 10% worst performing models
Scenario 5b Energy label re-scaling	5b1. Class A and B empty	Energy label is re-scaed according to the revised 2017 Energy Label Framework Directive. The best performing machine at the time of writing would be placed in Energy Label Class C
	5b2. Class A empty	The Energy Label is re-scaed according to the revised 2017 Energy Label Framework Directive. The best performing machine at the time of writing would be placed in Class B.
	5b3. Without empty classes	The Energy Label is re-scaed according to the revised 2017 Energy Label Framework Directive. The best performing machine at the time of writing would be placed in Class A.

3.4.1. Scenario 0: Business as Usual (BAU)

As in washing machines, the definition of the Business as Usual (BAU) scenario for washer-dryers is based on the assumption that no additional regulation is implemented. The energy consumption of the washer-dryers is assumed to follow the trend shown in the past years and to reach a "plateau", as further improvements of the energy consumption might come at a higher cost and are not then implemented as rapidly as in other scenarios.

3.4.2. Scenario 4: Modifications of the standard for measurement to bring it closer to actual consumption under real-life conditions

Scenario 4 assesses if a change in the standard for measuring energy consumption will trigger a technical improvement of those programmes used for testing, and that at the same time compares consumers' most commonly used programmes to the programmes which are most represented regarding testing conditions for washer-dryers.

Scenario 4 considers four sub-options

- **Scenario 4a:** WD SPLIT. This option keeps the current test standard conditions regarding the drying process (tested at full washing capacity). This scenario changes the washing programmes in accordance with the previous washing machine section to test the washing process.

¹⁷ Minimum Energy requirement

- **Scenario 4b:** WD REMOVE. This option keeps the testing of the wash cycle at full rated capacity, but the testing of the drying process at drying capacity. This change makes the testing closer to real-life conditions because consumers often remove certain laundry items from the wash load
- **Scenario 4c:** WD COMBI continuous: This option uses a continuous wash&dry cycle at the rated wash&dry capacity, which is usually lower than the rated capacity for washing only. This option also sets the testing conditions closer to real-life, use since it has been observed that consumers in approximately 33% of the cycles select a continuous wash&dry programme.
- **Scenario 4d** WD COMBI interrupted: This option uses an interrupted wash&dry cycle at the rated wash&dry capacity. The machine stops washing before starting the drying cycle for approximately 30 min. This option maintains continuity with the current international measurement standard IEC 6252.

3.4.3. Scenario 5: Energy label and revised energy label scaling

In this overall scenario, two sub-options are explored: firstly to remove the current Energy Label and implement new Ecodesign requirements, and secondly to assess the ambition levels of the requirements for the Energy Label classes, if implemented.

In the first scenario (5a), several Ecodesign requirements options related to the energy consumption of washer-dryers were assessed in the review study. The first option explored is to set ecodesign requirements on the *washing performance* of the washer-dryers. This is an aspect that could align the washing process of the washer-dryers to the washing process of the washing machines. A minimum washing performance equal to the minimum washing performance for washing machines would ensure customer satisfaction with the WD washing performance, but it could lead to either an increase of the temperature and energy consumption of the standard cycles, or an increase of the duration of the standard cycles. Other minimum requirements applied to washing machines, such as a minimum energy requirement (MER) for the washing process, could also be considered for washer-dryers.

Historical data has shown that the washing performance of household washer-dryers has progressively increased, and that from 2015 almost all models have exhibited washing performance class A (equal to the minimum washing performance requirement for washing machines). Therefore, setting this requirement for washer-dryers would not seem to have a significant impact, and has thus not been modelled.

Setting Ecodesign requirements for the drying process has also been reviewed in the study. Two alternatives have been considered: firstly, either to set MER on the drying process or secondly to set MER on the wash&dry process. The second alternative examined was considered to be more coherent, and was studied in more detail. This alternative involved setting a MER for the wash&dry process overall, to try to ensure that the energy consumption of this whole process was restricted to a maximum "sensible" value. It remains to be decided if this requirement should affect the continuous wash&dry process, the interrupted wash&dry process, or both processes.

In this scenario, the option is explored to implement new MERs in three time-defined steps, or tiers:

- Tier 1: a maximum energy consumption of 0.85 kWh/kg in 2020;
- Tier 2: a maximum energy consumption of 0.80 kWh/kg in 2025; and
- Tier 3: a maximum energy consumption of 0.75 kWh/kg in 2030.

The measures are estimated to remove approximately the 30%10% worst-performing models on the EU market in 2030

Under these conditions, and with no Energy Labelling, it is assumed, as previously explained, that manufacturers would not be sufficiently encouraged to improve WDs' energy performance beyond the

mandatory requirements, since there would be no recognisable, marketable differentiation based on energy efficiency. Manufacturers could instead focus mainly on decreasing product costs, or focus on other, non-energy parameters. Some manufacturers, however, may continue to improve their products, and communicate this improved energy efficiency to consumers. As was mentioned in scenario 2a, the removal of the Energy Label would deny manufacturers a recognised, proven means of communicating energy efficiency to consumers. Hence, manufacturers would need to choose other communication methods, the disadvantage of which would be that their claims would be hard for consumers to verify, and could be spurious.

The second part of the scenario assesses the implementation of a revised EU Energy Label scale from A to G, in line with the requirements of the 2017 framework regulation on Energy Labelling. Three sub-scenarios differ mainly in the ambition of the requirements for the label classes. The sub-options for label reclassification have been modelled following the assumptions considered previously in scenario 2. The label class thresholds for the three sub-scenarios are shown in Table 7.

Table 7: Current energy label class distribution and for scenarios 5b1, 5b2 and 5b3.

Since 2011					Revision (kWh/kg)						
Label class	kWh/a	kWh/kg	kWh/a	kWh/kg	Label class	Scenario 5b1		Scenario 5b2		Scenario 5b3	
	min	min	max	max		min	max	min	max	min	max
A			150	0.68	A		0.29		0.38		0.42
B	150	0.68	178	0.81	B	0.29	0.37	0.38	0.46	0.42	0.48
C	178	0.81	205	0.93	C	0.37	0.47	0.46	0.54	0.48	0.56
D	205	0.93	231	1.05	D	0.47	0.57	0.54	0.64	0.56	0.66
E	231	1.05	253	1.15	E	0.57	0.70	0.64	0.76	0.66	0.77
F	253	1.15	284	1.29	F	0.70	0.85	0.76	0.89	0.77	0.90
G	284	1.29			G	0.85	1.04	0.89	1.05	0.90	1.05

To better understand the implications of the different thresholds it is important to know the energy consumption of some of the best available appliances currently on the market, which are shown in Table 4.

Table 8: Annual energy consumption of best available washer-dryers on the market in August 2017

	Declared energy consumption of the wash&dry process (9kg)		Estimated energy consumption of the wash&dry process (7kg)	
	(kWh/kg)	(kWh/a)	(kWh/kg)	(kWh/a)
A -40% (heat pump washer dryer)	0.41 kWh/kg	734 kWh/a	0.41 kWh/kg	570 kWh/a
A	0.68 kWh/kg	1224 kWh/a	0.68 kWh/kg	952 kWh/a

As explained similarly regarding Scenario 2 (Section 3.2.3), three levels of ambition for the EU Energy Label for WD have been modelled in several sub-scenarios under Scenario 5b.

Scenario 5b1 maintains Energy Label classes A and B empty (regarding current technology), and places heat pump-equipped washer-dryers in Energy Label Class C. This means that the empty Energy Label Classes A and B are intended as the incentive to reward future even more energy-efficient innovation, exploiting possible improvement potentials (although washer-dryers are not generally considered to be a fast-moving technology product). However, in this scenario, if washer-dryer technology changes in do not

progress sufficiently in the future, Energy Labelling scenario 5b1 bears the risk that there will not be any washer-dryer products that achieve Energy Label Class A over the next 8 years. Thus, there may be insufficient differentiation of products on the market, with regard to Energy Labelling. Most of the current ranges of products will be concentrated in Energy Label Classes F and G, and given the current knowledge/design implementation, in scenario 5b1 it would be very difficult to reach a good label class without integrating a heat pump into a WD. Owing to higher purchase prices of heat pump-equipped WDs, even though these products would have Energy Label Class C, there might be a lower-than-expected uptake of these WD machines by consumers. Furthermore, as most other washers would be placed in the low energy efficiency classes (E to G), this might result in the misperception that non-heat pump machines have low performance properties, also regarding non-energy related aspects e.g. washing and drying performance, overall.

Scenario 5b2 proposes to maintain Energy Label Class A empty (for currently-known technologies), but places heat pump-equipped machines in Energy Label Class B. Most of the currently-available machines would be classified in Energy Classes D to G. In scenario 5b2, it is assumed that manufacturers would subsequently be motivated to develop machines that could achieve higher Energy Label classes (shifting the tendency towards Classes B and C),

Scenario 5b3 would allow heat pump-equipped appliances (i.e. kWh/kg = 0.41) to be placed in Energy Label Class A from the start of the revision. This might be in conflict to the revised 2017 Energy Label regulation, as previously explained in Section 3.2.3, describing scenario 2, since c. 1% of currently-marketed WDs are equipped with a heat pump.

The sales distribution evolution forecasts in terms of energy efficiency classes over the years 2020-2030 for each of the scenarios 5a, 5b1, 5b2 and 5b3 are shown in Figure 28. It should be mentioned that it is difficult to estimate future sales distributions; however, variations in these predictions have a large influence on the outcome of estimated energy savings and other impacts.

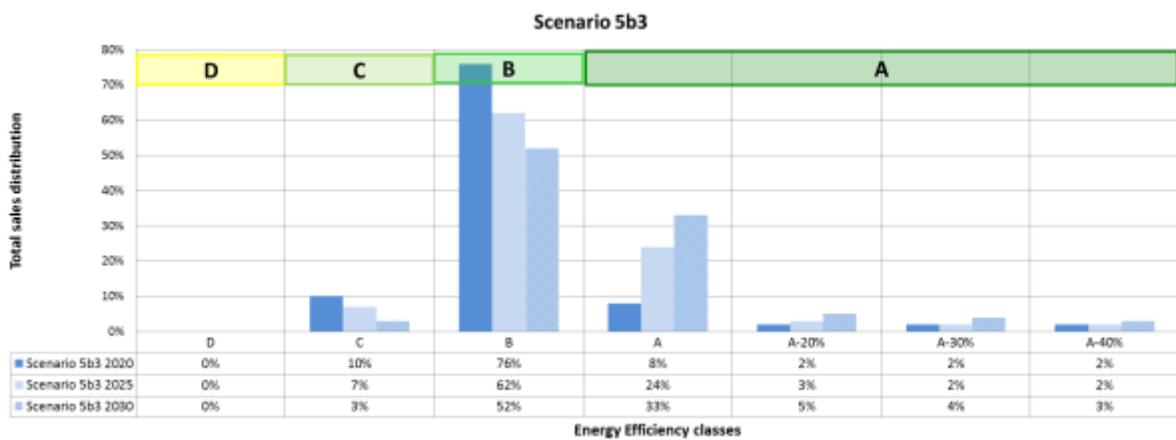
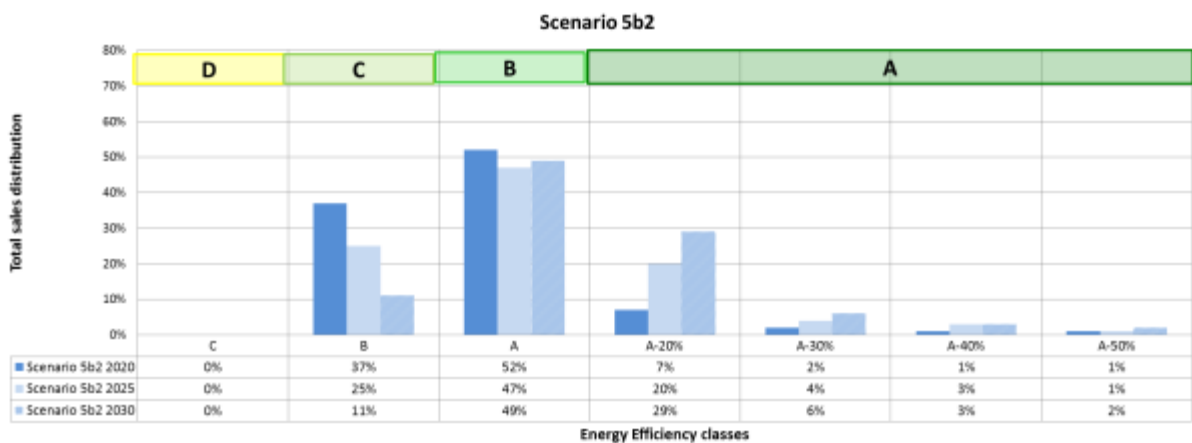
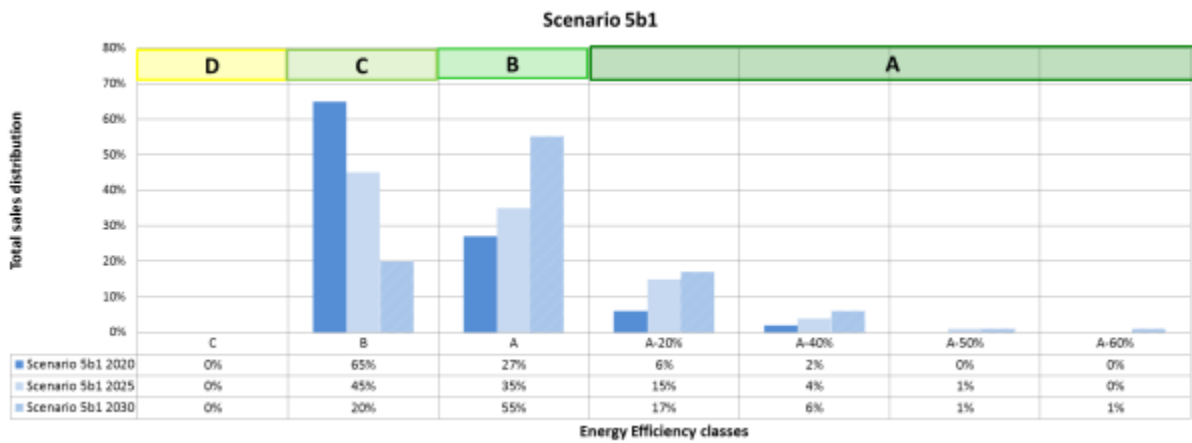


Figure 28: Estimated sales distribution for scenarios 5b1, 5b2 and 5b3

It is also possible that one or more other technology types, capable of competing with the heat pump in terms of energy efficiency might be developed. However, currently no high-efficiency possible alternatives have so far been identified during the review study..

3.5. Environmental significance of the proposed policy scenarios for washer-dryers

The options within **Scenario 4** do not estimate the environmental significance of the proposed sub-scenarios 4a, 4b, 4c and 4d in comparison to the BAU scenario. Scenario 4 instead focus on possible changes to the standard for measuring energy consumption, and how this standard could be closer to how the washer-dryers are used in real-life.

In theory, it is expected that the closer the standard for measurement is to reality, the greater the actual realised environmental benefits will be. This is because manufacturers are likely to optimise their equipment according to the revised standards. If the testing programme(s) associated with the revised standard are more realistic, then manufacturers' design changes should in turn yield real benefits, rather than solely artificially-projected improvements that do not materialise in reality (e.g., based on standard programmes that are not used so often). However, at the same time it should be kept in mind that any revised testing programmes will have to fulfil other requirements such as feasibility, reproducibility, avoidance of excessive costs for manufacturers and market surveillance authorities, etc.

Similarly to the results presented for scenario 2 regarding washing machines (Section 3.2.3), the several sub-options of Scenario 5 influence differently the evolution of the use of resources (energy and water) over time in the EU 28. The effects of the different sub-options of **Scenario 5** on energy and water consumption for the EU28 in the period 2015-2030 are shown in Figure 29 and Figure 30.

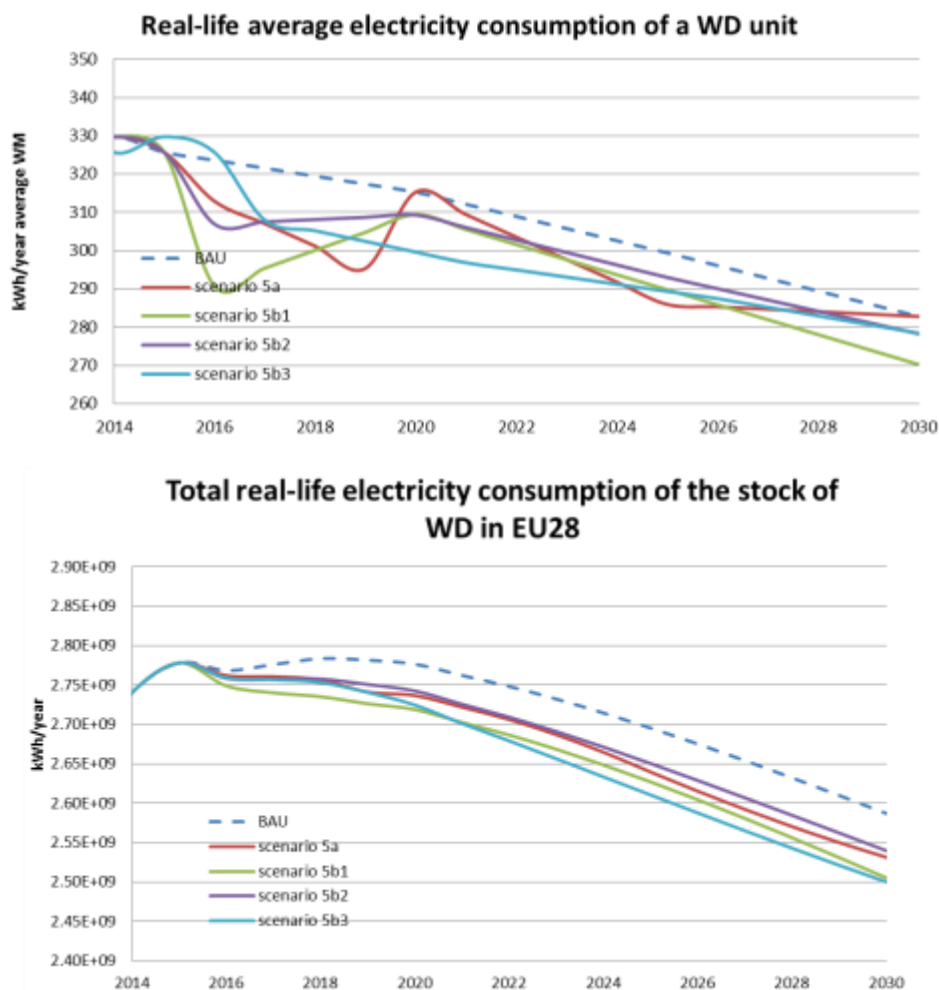


Figure 29: Estimated real-life average electricity consumption of a WD unit, and total electricity consumption of the stock of WD in EU28 for Scenarios BAU, 5a, 5b1, 5b2 and 5b3

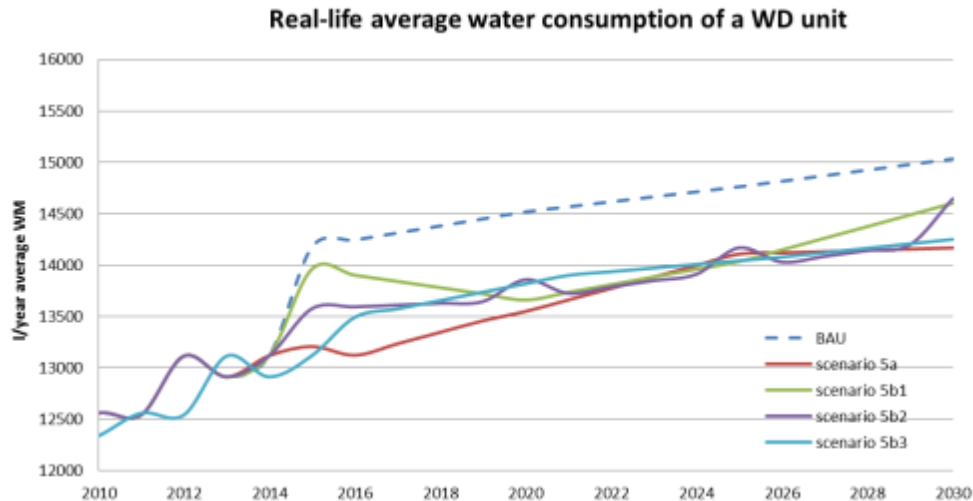


Figure 30: Estimated real-life water consumption of a WD unit for Scenarios BAU, 5a, 5b1, 5b2 and 5b3

Scenario 5b1, with the greatest ambition, provides the most resource-efficient results in terms of energy. This observation is reliant on the assumption that there will be a fast market penetration of those washer-dryers which are equipped with a heat-pump, owing to the higher energy savings that this technology can bring. However, as shown in section 3.1.4.2., the LCC of washer-dryers equipped with heat-pump technology is lower than for other appliances. Scenario 5a (Ecodesign only) shows the least promising results, although some savings could be achieved. This indicates that the implementation of a revised EU Energy Label tool on the market still has significant potential to save resources in the coming years. The results of scenario 5a partly rest on the assumption that the distribution of the appliances will probably split into two large groups (namely highly efficient machines, and secondly appliances that are placed in the lower market segment).

Figure 31 shows that maximum energy savings are also expected for scenario 5b1, followed by scenario 5b2, with energy savings, respectively, of 0.18 TWh/year and 0.17 TWh/year in 2030, respectively. These values represent, respectively, 6% and 7% of total EU28 washer-dryer energy consumption in the BAU scenario estimated in 2030. Maximum water savings of 7.6 million m³ per year are expected in 2030 for scenario 5b1 (representing approximately 4% of the EU 28 total water consumption estimated for the BAU scenario)

With regard to total consumer expenditure, all the options of scenario 5 show an increase over time. This is because utility prices, purchase price per machine and – importantly – the total number of machines in the EU28 stock are expected to increase in the coming years. Scenario 5a produces the least costly consumer expenditure option for consumers, followed by the scenario 5b3.

NB It should be note that increases in repairs, durability and other material efficiency Ecodesign/ Energy Label options are not considered in these Secario 5 discussions.

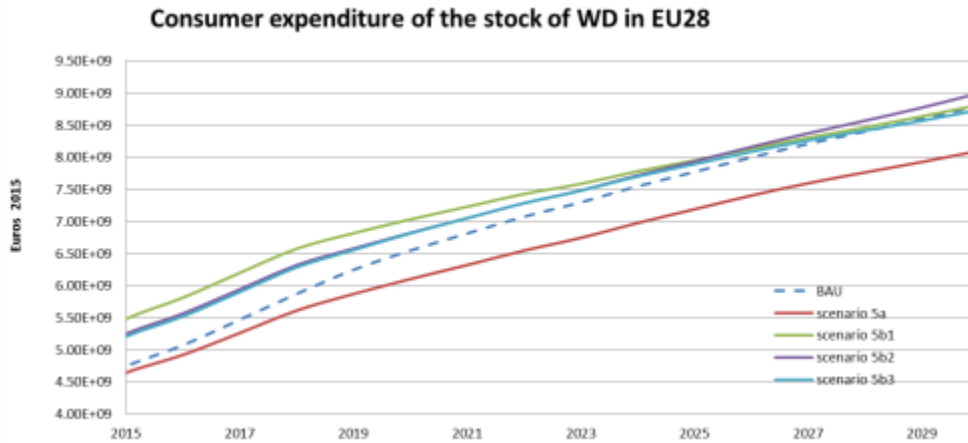


Figure 31: Estimate consumer expenditure for the washer dryers stock in EU28 compared to the BAU scenario for scenarios BAU, 5a, 5b1, 5b2 and 5b3

Finally, the impact on the expected job creation for the washer-dryer sector due to the implementation of ecodesign requirements or the re-scaling of the energy label is estimated to be similar to those discussed previously for washing machines (see Section 3.3).

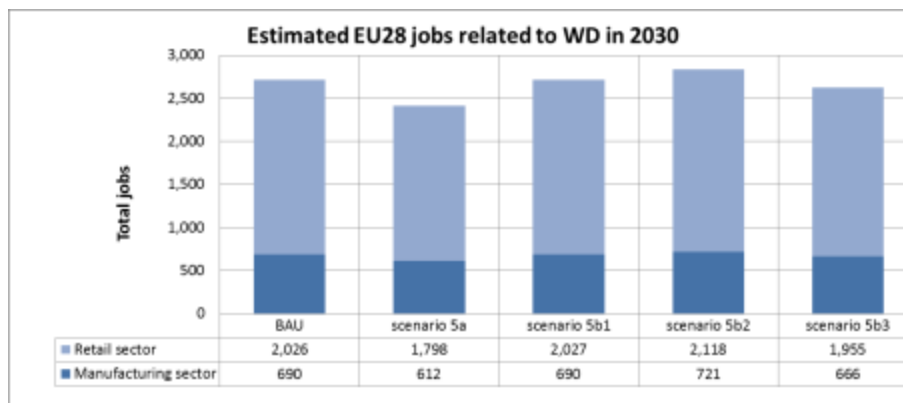


Figure 32: Estimated number of jobs by 2030 in the washer drrs sector (manufacturing and retail) in EU 28 under the conditions of the BAU scenario and scenarios 5a, 5b1, 5b2 and 5b3

4. PROPOSED MEASURES

4.1. Scope and exclusions

Scope

The scope of the current regulations will also apply to the revised regulations, being only slightly adapted by better delimiting household and non-household appliances by referring to the Low Voltage Directive 2014/35/EU, which is applicable to household appliances. A key revision is that household washer-dryers will henceforth be included in the revised scope of the Ecodesign and EU Energy Label regulations for household washing machines; to align the washer-dryer Energy Label with both Ecodesign rules, and the

2017 Regulation on Energy Labelling. Therefore, the definitions applicable to household washer-dryers have been added accordingly.

Exclusions

Household washing-machines and household washer-dryers powered solely by an internal battery will be excluded from the scope of the revised regulations. Non-household washing machines and non-household washer-dryers are also excluded from the scope of the revised ecodesign and energy label regulations for household washing machines and household washer-dryers. Non-household washing machines and non-household washer-dryers have distinct characteristics and uses, and are subject to another area of regulatory work with a different scope (i.e., as noted, inter alia, in the 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).

4.2. Proposed Draft Measures: Ecodesign and Energy Labelling

Based on the results of the review study as summarised in previous sections, new and revised Ecodesign and EU Energy Labelling measures are proposed for household washing machines and household washer-dryers. Table 9 gives a list of the measures proposed, together with their sub-options (depending on evaluation requirements) and the relevant annexes with the corresponding information.

The calculation methods of the performance parameters (Energy Efficiency Index, washing performance index, water consumption, spin drying efficiency index, etc) are aligned between the proposals for revising the Ecodesign and Energy Label regulations.

Table 9: Proposed Ecodesign and Energy label measures for washing machines and washer-dryers

Issue	Proposed measure	Annex
ECODESIGN REQUIREMENTS		
<u>Energy Efficiency Index (EEI) for washing machines</u>		
Reference values	EEI based on three different lineal SCEC (Standard Cycle Energy Consumption)	Annex 11.1.1
	EEI based on a non-lineal SCEC	
	EEI based on a lineal SCEC with loading factors	
Loadings	Fixed loadings: 2kg, 4kg and full load	Annex 11.1.2
	Proportional loadings: full, half and quarter load	
Number of parameters	EEI as a single parameter index	Annex 11.1
	EEI as a combination of two parameters: energy and time	Annex 11.13.2
<u>Energy Efficiency Index (C) for washer dryers</u>		
Testing programme	C based on the continuous wash&dry capacity (interrupted if not available) at full and half loadings	Annex 11.3
Drying target	C based on cupboard dry (0% residual humidity) final moisture content for the drying process	Annex 11.3
<u>Low power modes</u>		
Maximum duration	Left-on mode \leq 20 min	Annex 11.4
Maximum energy consumption	Left-on mode \leq 1W Left-off mode \leq 0.5W Delay start mode \leq 2W	
		Ecodesign requirement on the provision of information on the energy consumption of left-on mode, left-off mode and delay start mode

<u>Energy consumption of the programmes</u>		
Maximum energy requirement of the testing programmes	Ecodesign requirement on maximum energy consumption of the testing programmes at different loadings for washing machines and washer dryers	Annex 11.5
Energy consumption of other programmes	Ecodesign requirement on the provision of indicative information on the energy consumption of the main washing programmes at full or partial loads, or both	Annex 11.10
<u>Water consumption of the programmes</u>		
Maximum water requirement of the testing programmes	Ecodesign requirement on maximum water consumption of the testing programmes at different loadings	Annex 11.6
Water consumption of other programmes	Ecodesign requirement on the provision of indicative information on the water consumption of the main washing programmes at full or partial loads, or both	Annex 11.10
<u>Washing, rising and spin drying performance</u>		
Minimum washing performance	Harmonisation to the proposed testing programmes for washing machines	Annex 11.7
	Harmonisation to the proposed testing programmes for washer-dryers	Annex 11.7
Minimum rising performance	No inclusion of minimum rising performance	Annex 11.8
Spin drying performance	Harmonisation to the proposed testing programmes for washing machines	Annex 11.9
	No ecodesign requirement on minimum spin drying efficiency	Annex 11.9
	Ecodesign requirement on recommendations on the most appropriate spinning speed depending on the subsequent drying process	Annex 11.10
	Ecodesign requirement on the provision of indicative information on the remaining moisture content of the main washing programmes at full or partial loads, or both	Annex 11.10
<u>Other ecodesign requirements for washing machines</u>		
Washing cycle at 20C	Ecodesign requirement on the provision of a washing cycle at 20 °C	Annex 11.11
	Ecodesign requirement on identification of the washing cycle at 20 °C	Annex 11.11
Arrow for identifying testing programmes	No Ecodesign requirement	Annex 11.12
Duration of the testing programmes	Provision of information on the Energy Label, either as: - weighted duration of the testing programmes - duration of the longest testing programmes	Annex 11.13.1
	Inclusion of the duration in the EEI	Annex 11.13.2
	Ecodesign requirement on maximum duration of the testing programmes	Annex 11.13.3
Duration of other programmes	Ecodesign requirement on the provision of indicative information on the programme time	Annex 11.10
Hot fill	Ecodesign requirement on the provision of information on the existence of this option, how to get the potential benefits and possible counterproductive cases	Annex 11.14
Loading	Ecodesign requirement on the recommendation of washing full loads	Annex 11.15
Temperature of the testing programmes	Ecodesign requirement on reaching at least 52 °C for 15 min or another combination of time and temperature resulting in equivalent pathogen removal for the 60 °C cotton programme	Annex 11.17
	No ecodesign requirement on minimum temperature for the 40 °C cotton programme	Annex 11.17

Temperature of other programmes	Ecodesign requirement on the provision of information on the maximum temperature reached in each of the main washing programmes	Annex 11.10
<u>Ecodesign resource efficiency requirements</u>		
Instructions to users in the booklet of instructions on	Correct installation (including removal of transport screws when applicable, level positioning, connection to mains, connection to hot or cold water inlets)	Annex 11.18
	Correct and incorrect loading	
	Correct dosage of detergent and consequences of inadequate dosage	
	Energy and water saving, including programme and sub-programme option selection	
	Foreign object removal	
	Periodical cleaning, including optimal frequency, and procedure	
	Door opening between cycles, if applicable.	
	Periodical checks of filters, periodical decalcification, including optimal frequency, and procedure	
Identification of errors, the meaning of the errors, and the action required, including identification of errors requiring professional assistance		
Marking of Annex VII WEEE (2012/19/EU) components	Information requirements for refrigeration gases	Annex 11.19
	Identification marking on electrolytic capacitors containing substances of high concern	
Design for dismantling for the purposes of depollution, material recovery and recycling.	Design so that electric and electronic components (when present) can be: <ul style="list-style-type: none"> - easily identified - easily accessible - extracted 	Annex 11.19
Spare part availability horizon declaration	Declaration of spare part availability time horizon declaration	Annex 11.21
Spare part maximum delivery time	Maximum delivery time of two months to trade vendors, to repairers or directly to the consumers	Annex 11.22
Access to repair and maintenance information (RMI)	Unrestricted and standardised access to appliance repair and maintenance information to independent operators, including: <ul style="list-style-type: none"> (a) an unequivocal appliance identification; (b) service handbooks, including disassembly map/exploded view, and repair step manuals; (c) technical manuals; (d) component and diagnosis information (such as minimum and maximum theoretical values for measurements); (e) wiring and connection diagrams; (f) diagnostic trouble codes (including manufacturer specific codes); (g) information provided concerning, and delivered by means of, proprietary tools and equipment; and (i) data record information and two-directional monitoring and test data 	Annex 11.18
	Availability of training material to independent operators and authorised dealers and repairers	
	Fees for access to appliance repair and maintenance information	
	Implementing measures	
Expected durability of the appliance	Declaration of the expected durability of the appliance	Annex 11.18 to 11.23

ENERGY LABEL REQUIREMENTS (for washing machines)		
Energy consumption and energy efficiency classes	Re-scaling of the energy efficiency classes from A to G, leaving A class empty at the time of writing (Sept 2017)	Annex 11.24
	Re-calculation of the energy efficiency classes based on the new testing programmes	Annex 11.24
	Provision of information on weighted energy consumption (E_c) in kWh per cycle, rounded up with two decimals	Annex 11.26
Spin drying efficiency classes	Re-calculation of the energy efficiency classes based on the new testing programmes	Annex 11.25
	Provision of information of the spin drying efficiency class	Annex 11.26
Acoustic airborne noise emissions	Information on the airborne acoustic noise emissions during the washing process for the 40 °C cotton programme at full load, expressed in dB(A) re 1 pW, rounded to the nearest integer	Annex 11.26
	Airbone acoustic noise class for the washing process, marked with the appropriated symbol	
	Information on the airborne acoustic noise emissions during the spinning phase for the 40 °C cotton programme at full load, expressed in dB(A) re 1 pW, rounded to the nearest integer	
	Airbone acoustic noise class for the spinning phase, marked with the appropriated symbol	
Water consumption	Provision of information on weighted water consumption (W_c) in litres per cycle, rounded up with two decimals	Annex 11.26
Rated capacity	Provision of information on rated capacity, in kg, for the 40°C cotton programme at full load,	Annex 11.26
Duration of the testing programme	Inclusion of an icon with either - an average of the duration of the testing programmes and loads - the longest duration among the testing programmes and loads	Annex 11.13.1
Clear indication that the values refer to a combination of testing programmes and loadings		Annex 11.26
ENERGY LABEL REQUIREMENTS (for washer-dryers)		
Energy consumption and Energy Label efficiency classes	Re-calculation of the Energy Label classes based on the new testing programmes for a complete continuous wash&dry cycle (or interrupted wash&dry cycle if not available)	Annex 11.27
	Re-calculation of the Energy Label classes for the washing cycle based on the new testing programmes	
Water consumption	Provision of information on weighted water consumption (W_c) in litres per cycle for a complete continuous wash&dry cycle (or interrupted wash&dry cycle if not available), rounded up with two decimal	Annex 11.27
Rated capacity	Provision of information on rated capacity (in kg), regarding a complete wash&dry cycle for the 40°C cotton programme at full load (or interrupted wash&dry cycle if not available)	Annex 11.28 11.26
Acoustic airborne noise emissions	Information on the airborne acoustic noise emissions during the washing process for the 40 °C cotton programme at full load, expressed in dB(A) re 1 pW, rounded to the nearest integer	Annex 11.28
	Airbone acoustic noise class for the washing process marked with the appropriated symbol	
	Information on the airborne acoustic noise emissions during the spinning phase for the 40°C cotton programme at full load, expressed in dB(A) re 1 pW, rounded to the nearest integer	
	Airbone acoustic noise class for the spinning phase marked with the appropriated symbol	

	Information on the airborne acoustic noise emissions during the drying phase for a continuous wash&dry cycle (or interrupted wash&dry cycle if not available) at full load, expressed in dB(A) re 1 pW, rounded to the nearest integer	
	Airborne acoustic noise class for a continuous wash&dry cycle (or interrupted wash&dry cycle if not available) marked with the appropriated symbol	
Duration of the testing programme	Inclusion of an icon with either - an average of the duration of the testing programmes and loads - the longest duration among the testing programmes and loads	Annex 11.13.1
Clear indication that the values refer to a combination of testing programmes and loadings		Annex 11.28

5. FORM OF IMPLEMENTING MEASURES

Each of the two separate implementing measures (Ecodesign and Energy Labelling, respectively) will each take the form of a Regulation, i.e., directly applicable in all EU Member States.

The proposed draft Ecodesign requirements relate to the energy efficiency of the products within the scope of the Ecodesign Regulation. In addition, the Ecodesign proposals contain requirements on the provision of supplementary product information, and also information requirements related to resource efficiency aspects.

6. IMPACT ASSESSMENT

An impact assessment of the possible policy measures will be carried out pursuant to Article 15(4)(b) of Directive 2009/125/EC. Several policy options for achieving a market transformation fulfilling the appropriate level of ambition will be considered, including: 1) no new EU action ('business-as-usual' BAU case); 2) revocation of the existing regulations; 3) a self-regulation measure concluded by industry; and 4) revision of the existing regulations.

Given that the eligibility criteria defined in the Ecodesign Directive (i.e. economic significance, significant environmental impact and significant savings potential) are still fully met, and since the relevant industry sector has not submitted a proposal for a valid self-regulation measure, options 2 and 3 were discarded from the outset. Instead, the analyses in the impact assessment will concentrate on the revision of the existing Ecodesign and EU Energy Labelling regulations for household washing machines and household washer-dryers.

The impacts across the EU 28 Member States of a policy option that introduces revised Ecodesign requirements for household washing machines, and includes new Ecodesign measures for household washer-dryers, together with a revised EU Energy Label for household washing machines and household washer-dryers, will be assessed against the 'business as usual' scenario. Based on an assessment of costs and benefits, it is probable that a combination of Ecodesign requirements for household washing machines and household washer-dryers, together with revised Energy Labelling classes will emerge as the preferred option to address the noted regulatory and market failures that still exist for these two product groups. Without prejudice to the subsequent formal Impact Assessment study, from initial assessments to date, a possible resulting combination of Ecodesign requirements and Energy Labelling revisions might be expected to have the following results:

- Ecodesign requirements: it is likely that household washing machines and household washer dryers will fulfil potential cost-effective improvements in terms of energy use and material efficiency

- The EU Energy Labelling scheme should create market transparency for consumers, and provide incentives for manufacturers to continue to innovate/invest in energy efficiency
- The environmental impacts of use-phase energy and water consumption should be significantly reduced, and the resource efficiency significantly increased, with regard to the household washing machines and household washer-dryers within scope,
- The resulting revised clear and transparent legal framework will ensure continuing fair competition, at the same time as achieving the above resource efficiency progress
- The proposed measures should result in enhanced competitiveness in the industry sectors concerned
- Harmonised EU-wide requirements for the placing of household washing machines and household washer-dryers on the EU market will lead to the lowest possible administrative burdens and costs for economic operators
- No disproportionate burdens or significant additional costs for manufacturers will result from the proposed measure. Re-design cycles and the pace of innovation have been fully taken into account.

7. POSSIBLE OVERLAP WITH OTHER ECODESIGN MEASURES

7.1. European legislation

The following regulations are relevant to the energy and environmental aspects of household washing machines and household washer-dryers placed on the EU market. Some of these measures are currently being reviewed, the possible repercussions of which will need to be revisited during the Impact Assessment, where the associated review changes and timeline has consequences:

- 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.
- Commission Regulation (EU) No 801/2013 of 22 August 2013 amending Regulation (EC) No 1275/2008 with regard to ecodesign requirements for standby, off mode electric power consumption of electrical and electronic household and office equipment, and amending Regulation (EC) No 642/2009 with regard to ecodesign requirements for televisions
- 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 and repealing Regulation (EC) No 842/2006

Additionally, the resource-efficiency requirements in this proposed measure are in line with the provisions of the Directive 2012/19/EU of 4 July 2012 on waste electrical and electronic equipment (WEEE). Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), and Regulation (EC) 1272/2008 of the European Parliament and of the Council on classification, labelling and packaging of substances and mixtures (CLP) might be of relevance in case of household washing machines and washer-dryers containing substances of very high concern.

Directive 2011/65/EU of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) is relevant in electronic equipment production.

Please note that it has already been attempted to take into account horizontal measures, including the above-mentioned Regulation 1275/2008 on standby, and Regulation 801/2013 on networked standby, in the drafting of this measure for the possible overlap of specific articles or specific aspects.

7.2. International legislation

International legislation and standards have been thoroughly analysed in the review study. Apart from international standards on performance of household washing machines and household washer-dryers (IEC 60456 'Clothes washing machines for household use – Methods for measuring the performance' and IEC 62512 'Electric clothes washer-dryers for household use – Methods for measuring the performance'), no other international standards are directly related to the revision of the EU Ecodesign and Energy label regulations for household washing machines and household washer-dryers.

8. MEASUREMENTS AND CALCULATIONS

Measurements and calculations of the relevant product parameters should be performed using harmonised standards established in accordance with Article 10 of Directive 2009/125/EC, the reference numbers of which have been published in the Official Journal of the European Union, or using other reliable, accurate and reproducible methods which take into account the generally recognised state-of-the-art of testing, technology and relevant policies, and which produce results deemed to be of low uncertainty.

Requirements for calculation and measurement methods are specified in Annex II of the draft Working Documents for the proposed Ecodesign measures, and in Annex III of the draft Working Documents for the Energy Labelling measure. Following the extension of the scope of both regulation to include household washer-dryers, and the proposal regarding new standard cotton programmes, it is understood that the European Commission in co-operation with CEN/ CENELEC will request and work on, respectively, the necessary adaptations of the existing measurement standards, in order to provide appropriate, accurate and relevant measurement methods for all household washing machines and household washer-dryers covered by the scope of the proposed measures.

9. CONFORMITY ASSESSMENT

When performing the market surveillance checks referred to in Article 3 (2) of Directive 2009/125/EC, Member States' Market Surveillance Authorities (MSAs) are obliged to apply the verification procedure for the requirements in the Ecodesign and the Energy Labelling measures stipulated. In the present case, these are described, respectively, in Annex III of the draft revised EU Ecodesign Working Documents for household washing machines and washer-dryers, and in Annex IX of the draft revised EU Energy Label Working Documents for household washing machines and washer-dryers. The verification tolerances set out in the above-mentioned Annexes relate only to the verification of the measured parameters by Member States' MSAs, and must not be used by the manufacturer or importer as an allowed tolerance to establish the values in technical documentation.

Verification of resource efficiency parameters: when verifying the compliance of a product model with one of the 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, the following procedure should, at a minimum, apply to:

point (1) 'Information requirements for refrigeration gases': Market surveillance authorities shall 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 the household washing machine and household washer-dryer ': Market surveillance authorities shall disassemble with 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 and identify the type and the number of fastening techniques(s) to be unlocked, and tool(s) required.

point (3) 'Declaration of spare part availability: Market surveillance authorities shall identify that at the point of sale (at the retailer site or online) the requested information on the spare part availability is visibly and legibly disclosed to the consumer and that this information is also in the booklet of instructions. The market surveillance authorities shall randomly select, order from the manufacturer or trade vendors and check the delivery of the spare parts that the manufacturers declared as necessary for the use of the appliance.

point (4) 'Spare part maximum delivery time': Market surveillance authorities 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 shall be the starting date of the three weeks period. In case an order is delivered but not within the three weeks period the market authority shall repeat the verification with another test sample of spare parts. A manufacturer is not meeting the Regulation's requirements if for the same product more than 3 orders of spare parts do not meet the three weeks maximum delivery time without acceptable justification of an event of force majeure.

point (5) 'Access to Repair and Maintenance Information': Market surveillance authorities shall check that the access to repair and maintenance information is provided, organised and includes the information requested. The market authorities may organise a blind test to verify that the information is accessible to independent operators in non-discriminatory conditions. The market surveillance authorities shall check the registry of requests in the required data base 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 MSA must take appropriate measures to ensure compliance. The manufacturer is then obliged to take subsequent corrective actions, amendments and/or supplements, as requested by the MSA(s), and to 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 compiling this document – September 2017) for household washing machines and household washer-dryers on the market.

10.1 Household Washing Machines

The best available technology for household washing machines, on an individual machine basis, in terms of the energy and water consumption, washing efficiency and airborne acoustic noise emissions during washing/spinning for the standard 60°C cotton programme at full load, is identified as follows:

Data from CECED database 2015

- (1) Household washing machine with a rated capacity of 4 kg:
 - (a) energy consumption: 0.6 kWh/cycle (or 0.15 kWh/kg) (overall annual consumption of 124 kWh/year)
 - (b) water consumption: 26 litres/cycle (5,720 litres/year for 220 cycles)
 - (c) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (d) airborne acoustic emissions during washing/spinning: 59 dB(A)/77 dB(A)
- (2) Household washing machine with a rated capacity of 5 kg:
 - (a) energy consumption: 0.56 kWh/cycle (or 0.11 kWh/kg) (annual consumption of 82 kWh/year)
 - (b) water consumption: 40 litres/cycle (8,800 litres/year for 220 cycles)
 - (c) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (d) airborne acoustic emissions during washing/spinning: 58 dB(A)/82 dB(A)
- (3) Household washing machine with a rated capacity of 6 kg:
 - (a) energy consumption: 0.47 kWh/cycle (or 0.067 kWh/kg) (overall annual consumption of 104 kWh/year)
 - (b) water consumption: 33 litres/cycle (7,300 litres/year for 220 cycles)
 - (c) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (d) airborne acoustic emissions during washing/spinning: 52 dB(A)/73 dB(A)
- (4) Household washing machine with a rated capacity of 7 kg:
 - (a) energy consumption: 0.6 kWh/cycle (or 0.15 kWh/kg) (overall annual consumption of 124 kWh/year)
 - (b) water consumption: 39 litres/cycle (8,500 litres/year for 220 cycles)
 - (c) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (d) airborne acoustic emissions during washing/spinning: 52 dB(A)/73 dB(A)
- (5) Household washing machine with a rated capacity of 8 kg:
 - (a) energy consumption: 0.42 kWh/cycle (or 0.05 kWh/kg) (overall annual consumption of 92.4 kWh/year)
 - (b) water consumption: 46 litres/cycle (10,120 litres/year for 220 cycles)
 - (c) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (d) airborne acoustic emissions during washing/spinning: 48 dB(A)/73 dB(A)
- (6) Household washing machine with a rated capacity of 9 kg:
 - (a) energy consumption: 0.57 kWh/cycle (or 0.063 kWh/kg) (overall annual consumption of 130 kWh/year)
 - (b) water consumption: 47 litres/cycle (10,340 litres/year for 220 cycles)
 - (c) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (d) airborne acoustic emissions during washing/spinning: 52 dB(A)/73 dB(A)

Data from topten.eu (September 2017)

- (3) Household washing machine with a rated capacity of 6 kg:
- (a) energy consumption: 0.62 kWh/cycle (or 0.10 kWh/kg) (overall annual consumption of 129 kWh/year)
 - (b) water consumption: 38 litres/cycle (8,390 litres/year for 220 cycles)
 - (c) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (d) airborne acoustic emissions during washing/spinning: 50 dB(A)/77 dB(A)
- (5) Household washing machine with a rated capacity of 8 kg:
- (a) energy consumption: 0.49 kWh/cycle (or 0.06 kWh/kg) (overall annual consumption of 97 kWh/year)
 - (b) water consumption: 47 litres/cycle (10,299 litres/year for 220 cycles)
 - (c) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (d) airborne acoustic emissions during washing/spinning: 51 dB(A)/78 dB(A)
- (6) Household washing machine with a rated capacity of 9 kg:
- (a) energy consumption: 0.64 kWh/cycle (or 0,07 kWh/kg) (overall annual consumption of 105 kWh/year)
 - (b) water consumption: 47 litres/cycle (10,340 litres/year for 220 cycles)
 - (c) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (d) airborne acoustic emissions during washing/spinning: 49 dB(A)/75 dB(A)

10.2 Household Washer-Dryers

The best available technology for household washer-dryers, in terms of their energy and water consumption, washing efficiency and airborne acoustic noise emissions during washing/spinning for the standard 60°C cotton programme at full load, is identified as follows:

Data from CECED database 2015

- (1) Household washer dryer with a washing rated capacity of 6 kg:
- (a) energy consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 4.08 kWh/cycle (overall annual consumption of 898 kWh/year)
 - (b) energy consumption of a washing cycle (washing and spinning only) at full load and at standard 60°C cotton programme: 0.8 kWh/cycle (overall annual consumption of 176 kWh/year)
 - (c) water consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 79 litres/cycle (17,380 litres/year for 220 cycles)
 - (d) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (e) airborne acoustic emissions during washing/spinning/drying: 47/73/58 dB(A)
- (2) Household washer dryer with a washing rated capacity of 7 kg:
- (a) energy consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 4.76kWh/cycle (overall annual consumption of 1,047kWh/year)
 - (b) energy consumption of a washing cycle (washing and spinning only) at full load and at standard 60°C cotton programme: 0.8 kWh/cycle (overall annual consumption of 176 kWh/year)
 - (c) water consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 72 litres/cycle (15,840 litres/year for 220 cycles)
 - (d) washing efficiency index of $1.03 \geq I_w > 1.00$
 - (e) airborne acoustic emissions during washing/spinning/drying: 47/73/58 dB(A)
- (3) Household washer dryer with a washing rated capacity of 8 kg:

- (a) energy consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 3.8 kWh/cycle (overall annual consumption of 836 kWh/year)
- (b) energy consumption of a washing cycle (washing and spinning only) at full load and at standard 60°C cotton programme: 1.04 kWh/cycle (overall annual consumption of 229 kWh/year)
- (c) water consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 70 litres/cycle (15,400 litres/year for 220 cycles)
- (d) washing efficiency index of $1.03 \geq I_w > 1.00$
- (e) airborne acoustic emissions during washing/spinning/drying: 49/73/66 dB(A)

(4) Household washer dryer with a washing rated capacity of 9 kg:

- (a) energy consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 3.67 kWh/cycle (overall annual consumption of 807 kWh/year)
- (b) energy consumption of a washing cycle (washing and spinning only) at full load and at standard 60°C cotton programme: 1.09 kWh/cycle (overall annual consumption of 240 kWh/year)
- (c) water consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 69 litres/cycle (15,180 litres/year for 220 cycles)
- (d) washing efficiency index of $1.03 \geq I_w > 1.00$
- (e) airborne acoustic emissions during washing/spinning/drying: 49/75/66 dB(A)

(5) Household washer dryer with a washing rated capacity of 11 kg:

- (a) energy consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 6.73 kWh/cycle (overall annual consumption of 1,480 kWh/year)
- (b) energy consumption of a washing cycle (washing and spinning only) at full load and at standard 60°C cotton programme: 1.13 kWh/cycle (overall annual consumption of 248 kWh/year)
- (c) water consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 120 litres/cycle (26,400 litres/year for 220 cycles)
- (d) washing efficiency index of $1.03 \geq I_w > 1.00$
- (e) airborne acoustic emissions during washing/spinning/drying: 47/72/58 dB(A)

Data from topten.eu (September 2017)

(1) Household washer dryer with a washing rated capacity of 8 kg:

- (a) energy consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 3.45 kWh/cycle (overall annual consumption of 760 kWh/year)
- (b) energy consumption of a washing cycle (washing and spinning only) at full load and at standard 60°C cotton programme: 1.04 kWh/cycle (overall annual consumption of 229 kWh/year)
- (c) water consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 64 litres/cycle (14,000 litres/year for 220 cycles)
- (d) washing efficiency index of $1.03 \geq I_w > 1.00$
- (e) airborne acoustic emissions during washing/spinning/drying: 47/72/-- dB(A)

(2) Household washer dryer with a washing rated capacity of 9 kg:

- (a) energy consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 3.34 kWh/cycle (overall annual consumption of 734 kWh/year)
- (b) energy consumption of a washing cycle (washing and spinning only) at full load and at standard 60°C cotton programme: 1.1 kWh/cycle (overall annual consumption of 242 kWh/year)
- (c) water consumption of a complete cycle (washing, spinning and drying) at full load and at standard 60°C cotton programme: 63 litres/cycle (13,800 litres/year for 220 cycles)
- (d) washing efficiency index of $1.03 \geq I_w > 1.00$
- (e) airborne acoustic emissions during washing/spinning/drying: 51/77/66 dB(A)

11. REFERENCES

CECED databases from 2005-2016

Prakash, S.; Dehoust, G.; Gsell, M.; Schleicher, T. & Stamminger, R. in cooperation with Antony, F., Gensch, C.-O., Graulich, Hilbert, I., & Köhler, A. R. (2016). Einfluss der Nutzungsdauer von Produkten auf ihre Umweltwirkung: Schaffung einer Informationsgrundlage und Entwicklung von Strategien gegen „Obsoleszenz“: Final report [Influence of the service life of products in terms of their environmental impact: Establishing an information base and developing policies against "obsolescence"]

Tecchio, P., Ardente, F. and Mathieux, F., *Analysis of durability, reusability and reparability — Application to dishwashers and washing machines*, EUR 28042 EN, doi:10.2788/51992.ES calculations

Honisch M1, Stamminger R, Bockmühl DP., Impact of wash cycle time, temperature and detergent formulation on the hygiene effectiveness of domestic laundering. *J Appl Microbiol.* 2014 Dec;117(6):1787-97. doi: 10.1111/jam.12647. Epub 2014 Oct 13.

ANNEXES

Annex 1: Energy consumption

11.1. Calculation of the Energy Efficiency Index (EEI_{40°C}) for washing machines and the washing process of washer-dryers

It is proposed to keep the calculation of the EEI value similar to the current formulation, but with several modifications:

- 'left-on' and 'left-off' modes are taken out of the formula. This allows for simplification. However, maximum power consumption of the 'left-on mode', 'left-off mode' and 'delay mode' and maximum duration of the 'left-on mode' until the power management function applies are proposed
- instead of defining the energy consumption per year, the energy consumption values will be declared and displayed per cycle.
- a new programme is proposed for testing in accordance with the user behaviour survey 2015
- a new combination of loadings is proposed for testing in accordance with the outcomes of the user behaviour survey 2015
- a new reference value (denominator of the EEI formula)

Currently, the Energy Efficiency Index (EEI) formula used to classify an appliance is calculated according to the following equation :

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

where:

AE_C = weighted annual energy consumption of the household washing machine

SAE_C = standard annual energy consumption of the household washing machine

Since January 2013, according to the second Tier of Regulation (EC) No 1275/2008 for standby and off-mode, all household washing machines are required to be equipped with a power management system reverting automatically to 'off-mode' after the end of the programme. However, this is not the case for household washer-dryers. Another equation, established in Regulation (EC) No 1015/2010, is currently applied for calculating the AE_C , taking into consideration the effective duration of 'left-on mode'.

$$AE_C = E_t \times 220 + \frac{\{P_l \times T_l \times 220 + P_o \times [525600 - (T_l \times 220) - (T_l \times 220)]\}}{60 \times 1000}$$

Where

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

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

P_o = weighted power in 'off mode' for the standard washing cycles, 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 out the 'left-on mode' and 'off-mode' from the calculation of the annual energy consumption, as their contribution is solely c. 2% on average. Instead, what has been introduced a maximum power consumption cap for the 'left-on mode', and a maximum time duration of the 'left-on mode' until the power management function cuts in. Therefore, it is proposed to simplify the formula.

Additionally, the energy consumption of the wash cycle is proposed to be reported by cycle per se, instead of annually. This means that the average measure of the test (E_t) will be directly used in the calculations of the EEI. Hence, the current formula will be simplified, so that the equation is as follows:

$$AE_c = E_t$$

Current Situation

Currently, the calculation of the AE_c is based on a combination of cycles which clean normally soiled cotton laundry. These programmes are the 40°C cotton programme and the standard 60°C cotton programme, at full and half loads as shown in the equation below. The weighted energy consumption (E_t) is calculated in kWh rounded to three decimal places:

$$AE_c = \frac{[3 \times E_{t,60,full} + 2 \times E_{t,60,1/2load} + 2 \times E_{t,40,1/2}]}{7} \times 220$$

Where;

$E_{t,60,full}$ = energy consumption of the standard 60°C cotton programme at full load;

$E_{t,60,1/2load}$ = energy consumption of the standard 60°C cotton programme at half load;

$E_{t,40,1/2load}$ = energy consumption of the standard 40°C cotton programme at half load.

The current combination of programmes and loadings does not reflect data gathered regarding most commonly-reported user behaviour. There are several important aspects of mismatching between this combination and common user behaviour

- Consumers most frequently use the normal 40°C cotton programme
- The most frequently-used loading by consumers is 3.4 kg. This load has remained constant, even though the rated load capacity of washing machines has increased in recent years. It is necessary that either washing machines adapt to consumers' loading preferences to better use resources, or alternatively consumers might wish to fully load these larger machines.

Considering these points, two combinations of programmes and loadings are proposed for testing the washing machines. These combinations include:

- **Testing for classification according to the Energy Label:** a combination of the normal 40°C cotton programme and full, half and quarter loads is proposed for calculating the E_t of the washing machine. The E_t value is divided by a reference value to obtain the EEI. Fixed similar loads are also an option to consider, for instance 2kg and 4kg, in addition to the full load.
- **Testing for Ecodesign:** additionally a test at full load and using the 60°C cotton programme is proposed for ensuring that the machines can offer programmes that wash at higher temperature (e.g. hygienisation programmes)

11.1.1. Calculation of the $E_{EI_{40^{\circ}C}}$ reference values (SCEC)

The review studied revealed that washing machine manufacturers have tended to increase the rated capacity (maximum laundry load) of their machines, even though consumers still load the machines on average with 3.4 kg of laundry. This larger machine design tendency may be due to the way in which the current calculation of EEI has been formulated, rather than answering consumers' demands for larger machines. For this reason, in this study some corrective measures are proposed that imply new formulae for calculating the EEI values. Table 10 summarizes the options studied. The values proposed in this study are tentative values which should be considered solely as examples to illustrate the proposed modifications.

Table 10: Possibilities for the reference values of the EEI equation

OPTIONS FOR THE CALCULATION OF THE EEI		
Option	Sub-option	Comments
Modification of SAE_c (Standard Annual Energy consumption)	A. Three different SAE_c types, depending on the rated capacity of the washing machine	Three different reference lines are proposed for the following groups: a) WM with a rated capacity between 4.5kg and 6kg b) WM with a rated capacity between 6kg and 10kg c) WM with a rated capacity more than 10kg
	B. A non-linear SAE_c	A non linear reference lines is proposed following the example of the formula used to calculate the EEI of washer-dryers. This reference line is a negative exponential formula that flattens out at larger rated capacities.
Inclusion of loading factors	C. Inclusion of three loading factors in the calculation of E_t	Three weighting loading factors are proposed to be included in calculations of E_t . The values of the weighting loading factors will depend on the rated capacity of the washing machine. Three groups are proposed as in option A (above)

More in detailed the options presented are:

11.1.1.1. **Option A: three different linear SAE_c depending on the loading or a non-linear SAE_c**

The current formulation of the EEI is divided by SAE_c . SAE_c is currently a linear mathematical formula and should be indicated in kWh/year and rounded to two decimal places, as follows:

$$SAE_c = 47.0 \times c + 51.7$$

Where

c = rated capacity of the washing machine for the standard 60°C cotton programme at full load or the standard 40°C cotton programme at full load, whichever is the lower.

If the current SAE_c is plotted against the declared energy consumptions of the machines, a mismatch between them is observed. This mismatch is especially relevant for larger capacity washing machines (see Figure 33).

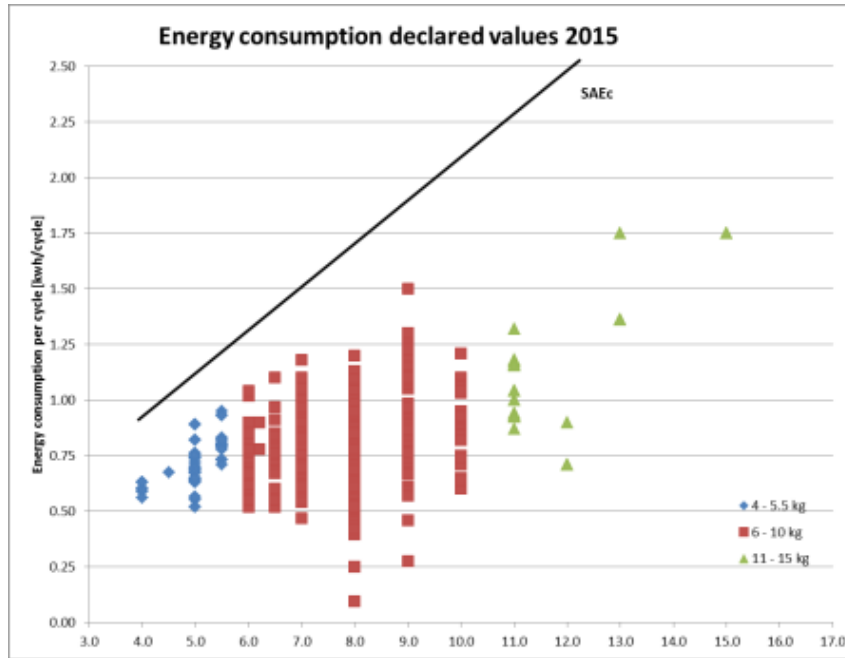


Figure 33: Current energy consumption declared values and the SAE_c line

In order to correct this mismatch, either of three different reference standard energy consumption formulae may be used, or alternatively a non-linear standard energy formulae.

Option A1 – three different SCE_c formulae depending on the rated capacity

The first option is illustrated in Figure 34. In this case, the calculation of the EEI values would be as shown in the following equation

$$EEI_c = \frac{1}{SCE_c} \times \frac{[2 \times E_{t,40,full} + 3 \times E_{t,40,1/2load} + 2 \times E_{t,40,1/4}]}{7} \times 100$$

Where:

- EEI_c : is the energy efficiency factor depending on the rated capacity of the washing machine
- SCE_c : is the standard cycle energy consumption per cycle that depends on the rated capacity for the washing machine
- $E_{t,40,full}$ is the energy consumption of the normal 40°C cotton programme at full load;
- $E_{t,40,1/2load}$ is the energy consumption of the normal 40°C cotton programme at half load;
- $E_{t,40,1/4load}$ is the energy consumption of the normal 40°C cotton programme at a quarter of the load;

The equation (above) requires a new formula for the standard energy consumption (SCE_c). This has been derived from the estimated energy consumption for the normal 40°C cotton programme at the three above-mentioned loads, for most of the currently-available washing machine models on the market. To estimate the values of the energy consumption for normal 40°C cotton programme, averages of energy consumption supplied by several manufacturers for several models for full- and half-load values were used. The energy consumption of the normal 40°C cotton programme for a quarter-load were estimated by means of the correlations provided by Laschi et al 2015.

As shown in Figure 34, the SCE_c has different values depending on the rated capacity of the washing machines. Three different groups are proposed. The first group includes the washing machines where the rated capacity at the normal 40 °C cotton programme is between 4kg and up to 6 kg, the second group consists of the washing machines with a rated capacity of 6 kg and above, but less than 10 kg; the third group consists of machines whose rated capacity is higher than 10 kg.

The proposed values for each of the SCE_c are shown in Table 11.

Table 11: Annual energy consumption of best available washer-dryers on the market in August 2017

Rated capacity	SCE_c formula
$c \leq 5\text{kg}$	$SCE_c = 0.116 c + 0.2241$
$5\text{ kg} < c \leq 10\text{ kg}$	$SCE_c = 0.0243 c + 0.7252$
$> 10\text{ kg}$	$SCE_c = 0.232 c + 1.3579$

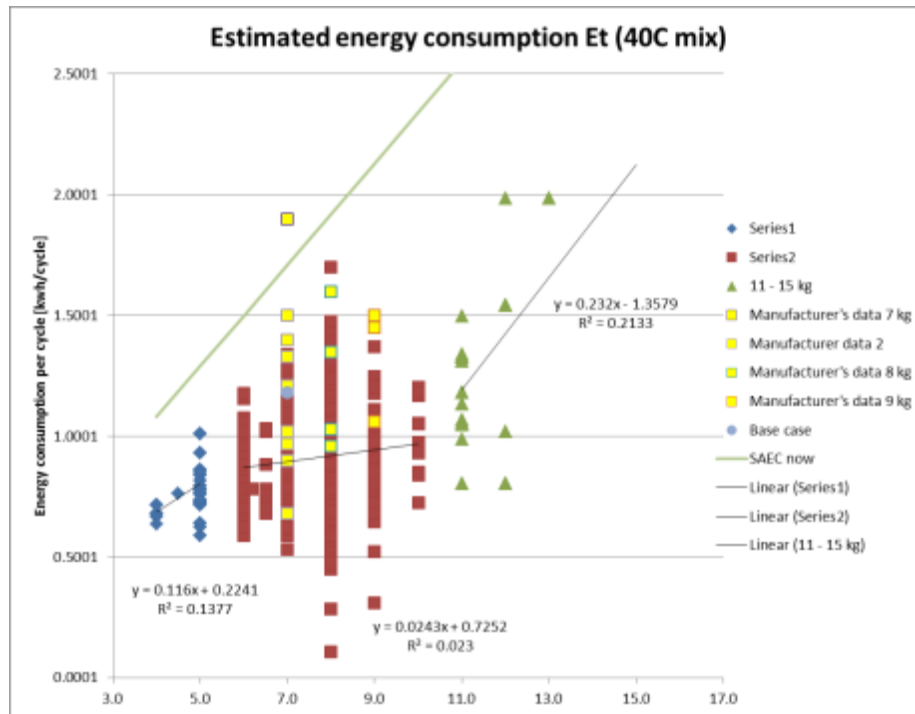


Figure 34: Three proposed SCE_c (grey lines) depending on the rated (laundry load) capacity of the washing machines in the review study database

As an advantage this option presents a better adaptation to the different groups of capacities of the machines but it presents two points of discontinuity. These two points can create problems regarding the verification and the tolerances that are usually applied. For example, if one machine declares to have a rated capacity of 5kg, the SAE_c formula to be applied is different as if a rated capacity of 5.1kg is measured.

Option A2 – a non-linear reference value.

The Regulation (EU) No 932/2012 on Ecodesign requirements for household tumble driers proposed the calculation of the EEI values for all household tumble driers that are not air-vented based on a non-linear SAE_c formula

$$SAE_{c, \text{ tumble driers}} = 140 x c^{0.8}$$

Following this example, a new formulation for the SCE_c of washing machines can be proposed. According to the data shown in Figure 35, the calculation of the EEI values in this option would be as follows

$$EEI_c = \frac{1}{SCE_c} x \frac{[2 x E_{t,40,full} + 3 x E_{t,40,\frac{1}{2}load} + 2 x E_{t,40,\frac{1}{4}}]}{7} x 50$$

Where

$$SCE_c = 0.5328 x c^{0.2582}$$

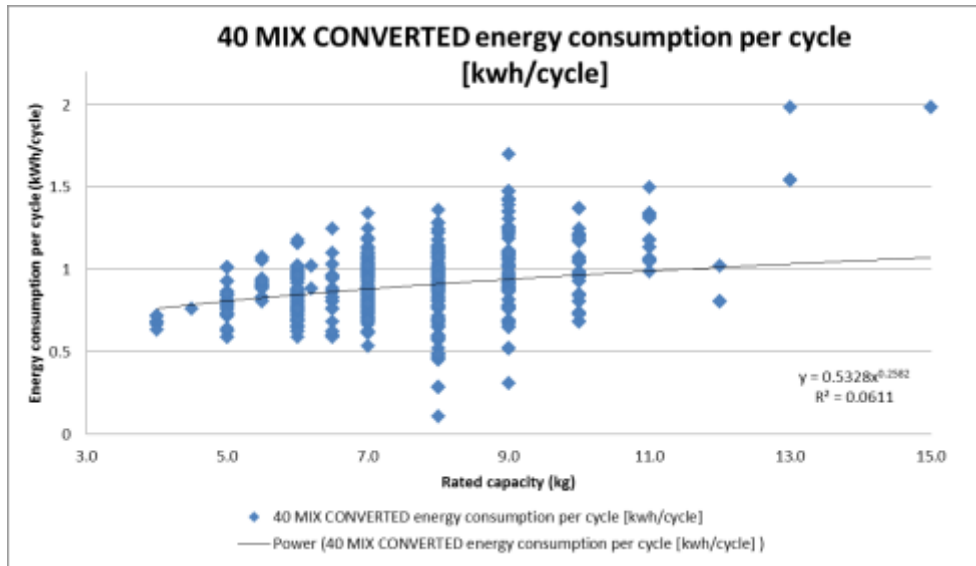


Figure 35: Proposed non-linear SCE_c formulae for the washing machines in the review study database

This option gets a flat reference value for larger capacities what can be perceived as a burden to develop washing machines with larger capacities and can prevent innovation in this segment of the machines. On the other, it is a continuous standard cycle energy formulae that may be very effective in reversing the current tendency of producing larger capacity washing machines.

11.1.1.2. Option B: Weighting factors based on loading of washing machines

As commented, the currently available "normal cotton 40°C programme" is proposed in this revision (in accordance with the results of the scenario 1, cf section 3.2.2) as the programme for testing at three different loads: full load, half load and one quarter of the rated capacity. The three loadings are chosen to test the adaptability of the machine to the load, since the review study revealed that loading is a key parameter to control the energy consumption of the cycles into achievable but ambitious values.

The proposed loading values (full, half and a quarter-load) are derived from increasing or decreasing, by 20%, the initial combination, depending on the rated capacity of the washing machine and the likelihood of it being loaded in that load range.

Another way to calculate the loading factors could be from the data reported by Kruschwitz 2015, used together with the CECED 2015 database. According to Kruschwitz 2015, consumers' average laundry loads amount to 3.4 kg ± 1.2 kg, while the average rated capacity of the washing machines in 2015 was 7.2 kg ± 1.2 kg.

If it is assumed that the consumer loading behaviour is normally distributed (Gaussian distribution) then the factors can be calculated by the following equations:

$$EEI_{total} = \frac{1}{SCE_c} \left[A \times Et_{40,full} + B \times Et_{40,\frac{1}{2}} + C \times Et_{40,\frac{1}{4}} \right] \times 100$$

$$A + B + C = 1$$

Where

A is the weighting factor for full loads
 B is the weighting factor for half loads
 C is the weighting factor for quarter-loads

These weighting factors depend on the rated capacity of the washing machine.. They aim to reorientate the equation, to place the emphasis on the most frequently-used loading patterns of washing machines by consumers, i.e., to reflect "real world conditions" more closely.

Another way of introducing the weighting factors can be by adding or subtracting a certain percentage from certain medium/middle point value. This would result in the values presented in Table 12.

Table 12: Proposed weighting factor depending on the rated capacity of the machines

Rated (laundry load) capacity (kg)	A	B	C
$c \leq 5$ kg	0,343	0,428	0,229
$5 \text{ kg} < c \leq 10$ kg	0,286	0,428	0,286
> 10 kg	0,229	0,428	0,343

Figure 36 shows the estimated average energy consumption of the models on the market for the normal 40°C cotton programme, considering the proposed weighting factors for the three rated capacity groups.

$$SCE_{c, 40C} = 0.08072 \times c + 0.18964$$

Where:

c is the rated capacity of the washing machine for the 40°C cotton programme

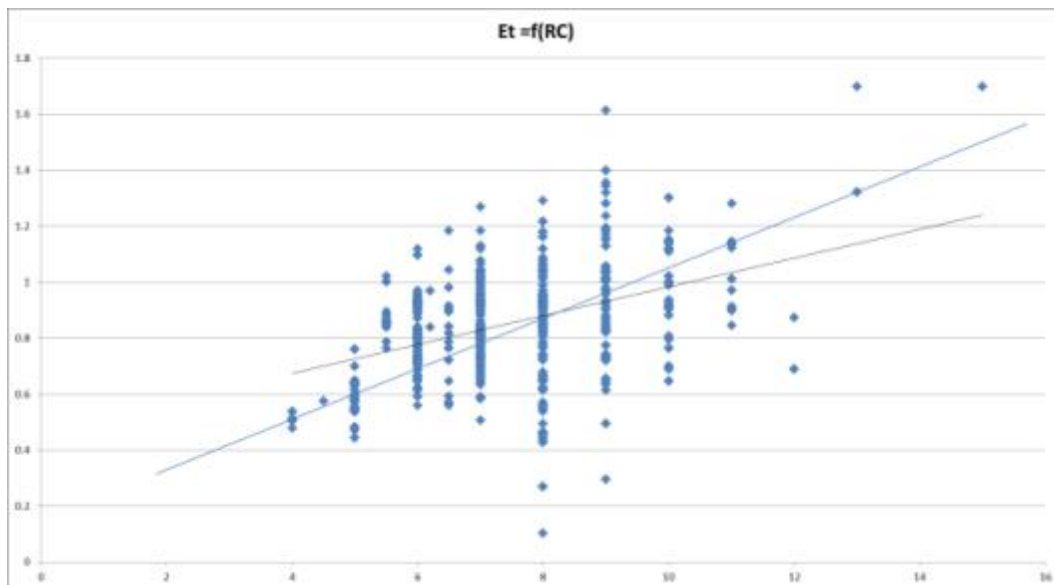


Figure 36: Proposed SCE_c when considering weighting factors based on observed consumer laundry loading patterns in the EEL calculation (grey line is the mathematical tendency and blue line is obtained by removing the outliers)

11.1.2. Calculation of the $EEL_{40°C}$: loading

There are intelligent washing machines on the market, which are capable of adapting their energy and water consumption to the actual washing load placed in them. This means that test cycles with partial load are necessary to assess their energy efficiency.

Until now, the calculation of the $EEl_{40^{\circ}C}$ has been based on three proportional loadings relative to the rated capacity, i.e., full-load, half-load and a quarter-load. Another possibility would be to work with two fixed loads (in terms of absolute kg being set) and the full load of the machine concerned.

a) Proportional loadings

The advantages of testing the machines with three proportional loadings are the simplification of the measurement standard, since the items to be washed can be easily distributed among the different test runs, and to a certain extent exhibit continuation with the current conditions.

The main disadvantage is that this method does not allow one to compare the performance of washing machines with different rated capacities.

b) Fixed loadings

Advantages of a fixed partial load compared to a proportional loading scheme are simplified testing, and counteracting the possible "rebound effect" concerning resource use via potentially unnecessary (for consumers) larger machines. Two partial loads around the average loading of the EU consumers (e.g. 2 kg and 4kg) can also prevent optimisation of the machine around a single partial load.

An additional advantage of this proposal is that direct comparison of washing machines for a specific fixed loading can be carried out, regardless of their rated capacity.

The exact values of the fixed loadings need to be decided in consultation with experts, but the values chosen would have to ensure that large machines could usefully adapt to small loads, and that they were optimised in this sense.

The disadvantage of this proposal is that the measurement standard would have to be revised.

Summary Table 13 shows the options proposed to be discussed at the Ecodesign Consultation Forum.

Table 13: Proposed loading methods for testing the washing machines

OPTIONS FOR THE CALCULATION OF THE EEI	
Option	Comments
Proportional loadings e.g. full-, half- and quarter-loads	- simplification of the measurement standard - continuation with the current testing method
Fixed loadings e.g. 2kg, 4kg and full load	- allows comparison between machines with different rated capacity - the measurement standard would need to be revised and an innovative way to split the laundry to wash has to be found.

11.2. Calculation of the $EEl_{60^{\circ}C}$

Finally, and regardless of the option considered for testing the washing machines for their classification according to the EU Energy Label, an additional testing method for the 60°C cotton programme is proposed. Testing has to be carried out to show compliance with the following requirement:

"the temperature measured in °C in the laundry core has to reach as a minimum, and irrespective of the load, 45 °C for the 'cotton 60 °C' cycle."

Additionally, the time during which the maximum temperature in the laundry core is maintained should be reported in the booklet of instructions. A maximum energy consumption of this cycle will be proposed. This value will be derived from the data in the database of CECED in 2008.

11.3. Calculation of the Energy Efficiency Index (C) for washer-dryers

The "wash&dry" function of washer-dryers is the main and most representative feature of this type of appliance. Therefore, it is the cycle proposed for testing. From the two types of wash&dry functions, it is proposed that the continuous wash&dry programme be selected for measuring. However, not all washer-dryer products on the market are equipped with this programme. Where the programme is not available in a certain product, it is proposed that an interrupted wash&dry programme be used for testing purposes.

The testing shall be performed at the wash&dry capacity for normally soiled cotton textiles suitable to be washed at 40°C. If no continuous process is available in the particular machine, a washing process and a separately selected drying process shall be selected with the lower value of the rated washing or rated drying capacity used as the capacity for the wash&dry process. Between both processes, the load shall be taken out from the washer-dryer, stored and reloaded for the drying process. Between the end of the washing process and the start of the drying process, a maximum time of 30 min is to be allowed, in accordance with standard IEC 62512.

The target final moisture content for the drying process shall be the moisture content denoted as "cupboard dry" (0% residual humidity)

The energy consumption value, "C", should be reported in kWh per kg of complete operation wash&dry cycle, determined in accordance with the test procedure of the most updated harmonised standard.

11.4. Low power modes for washing machines and washer-dryers

Standby modes are horizontally regulated by the Standby Regulation (Commission Regulation (EC) No 1275/2008), and Commission Regulation (EU) No 801/2013 amending the Standby Regulation. The "delay start" mode is the only low power mode distinct to washing machines and washer-dryers that is not already included and described in the above-mentioned standby regulations.

In accordance with the above-mentioned regulations, a so-called "vertical regulation" for this product group can be written, i.e., on a product-specific level. The requirements set out maximum energy consumption values for off-mode, left-on mode, networked connectivity and any other low power mode before starting the washing cycle (e.g. delay start mode). In this sense, it is proposed to include a restriction on the power consumption of the low power modes, plus other power states that the machine may enter after any programme. The following restrictions are proposed to come into force from December 2022.

- for all household washing machines and household washer-dryers, the power consumption of the 'left-on mode' or any other power state after any programme shall not exceed 1W
- for all household washing machines and household washer-dryers, the duration of the 'left-on mode' after the end of the any programme shall not exceed 20 minutes, after which the power management function shall automatically switch the machine to off-mode
- for all household washing machines and household washer-dryers, the power consumption of the 'left-off mode' shall not exceed 0.5W
- for all household washing machines and household washer-dryers, the power consumption of any mode before the initiation of the washing programme shall not exceed 2W.

Additionally, it could be written explicitly in the washing machine or washer-dryer regulation that the machine is required to switch any other low power mode to standby or off-mode using a power management system, after a period of 20 minutes has elapsed.

11.5. Minimum energy requirements for washing machines and washer-dryers

The latest Ecodesign requirements on energy efficiency for this product group came into force in 2013. This stipulated that for household washing machines with a rated capacity equal to or higher than 5 kg, the EEI shall be less than 59 (e.g. for a washing machine with 7kg rated capacity, this would equate to a mandatory upper energy consumption limit of 225 kWh/year). It should be taken into account that this is a second revision of the regulation, and that the current energy efficiency thresholds are seen to be appropriate to the presently-available state of technology development. Technically, and keeping the current formulation to calculate EEI, it would be possible to stipulate that larger washing machines must achieve better values of EEI than smaller washing machines. Therefore, a correction of this bias could be achieved, via either setting different MER depending on the rated capacity of the machines. Even if the use of the proposed loading factors (A, B and C) already were to adapt the EEI value to the rated capacity of the machines, different thresholds depending on the rated capacity would encourage manufacturers henceforth not to increase the size of the machines solely in order to obtain better Energy Label Class ratings; therefore, this potential tendency would be reduced.

The new minimum energy requirements for household washing machines and household washer-dryers should ideally be calculated according to the most recent information and data coming from the manufacturers, taking into account any changes in the product testing portfolio.

The Ecodesign minimum requirements Tiers for washer-dryers were estimated based on the data from CECED database 2015. The declared values of "C" with a washing process at the "standard 60°C cotton programme" were estimated from the 40°C cotton programme, and ranked from the lowest to the highest values. Ecodesign Tier 1 minimum requirements proposed to ban approximately the first block of machines with the highest energy consumption (approximately those above the model ranked as 550). Ecodesign Tier 2 minimum requirements proposed to ban the second block of machines with the highest consumption (remining approximately 350 models on the market as shown in the diagram below).

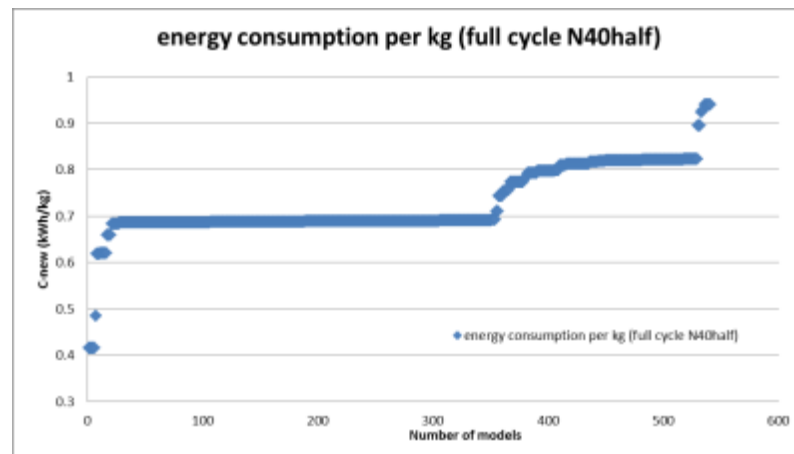


Figure 37: Estimated energy consumption per kg of the washer dryers

Annex 2 Water consumption

11.6. Water consumption

Water consumption is closely related to energy consumption. Market data show a steady decline of the water consumption over the past years. Household washing machines nowadays use quite a minimized amount of water to perform a washing cycle, and a restriction of the water consumption could jeopardize the washing performance and have impacts on the rinsing performance. It is proposed to maintain an indication of water consumption on the energy label, for information to the consumer.

The current annual water consumption (W_t) is given by the water consumption of the standard cotton 60°C programme at full load ($W_{t,60}$) and the usage frequency of 220 cycles per year:

$$W_t = W_{t,60}$$

$$AW_c = W_t \times 220$$

The new annual water consumption (W_t) should be based on the newly proposed testing programme. This means that the W_t shall be based on the water consumption of the cotton 40°C programmes at full load ($W_{t,40}$) and the usage frequency of 220 cycles per year. Therefore, it is proposed to formulae the water consumption as follows:

$$W_t = W_{t,40}$$

Additionally, it is proposed to keep the last minimum requirement on water consumption. For all household washing machines, the water consumption shall be

$$W_t \leq 5 \times c_1 \frac{1}{2} + 35$$

Finally, for household washer-dryers, a new Ecodesign requirement on the maximum water consumption has been included. These requirements apply to the washing process and are as strict as those of washing machines.

Annex 3 Washing performance, rinsing performance and drying performance

11.7. Washing performance

The current requirements on the washing performance index of the washing machines are proposed to keep unchanged (e.g. all household washing machines shall have a washing performance > 1.03).

For washer-dryers, the average washing performance of the 5 cycles shall be >1.03 and average washing performance for each individual treatment >1.00 (reference programme cotton 60°C)

11.8. Rinsing performance

The quality of rinsing of residues of detergents is important for consumers, especially for those more sensitive consumers who suffer from allergies to detergents, or washing residues, etc. Certain requirements (e.g. limits on the water consumption or on programme duration) might worsen the rinsing performance quality.

Introducing a rinsing performance for washing machines and washer-dryers (e.g. a minimum number of rinsing cycles, or providing this information on the Energy Label) would allow consumers to receive a guarantee of a certain minimum rinsing performance in the testing programmes. However, these measures would imply the existence of a measurement standard.

For the time being there is no finalised and recognised measurement standard, owing to current reasons surrounding a lack of reproducibility of ongoing draft methods. The so called 'LAS' standard method recently finalized by CENELEC SWG 18 and IEC WG20 would most likely be also applicable to washer-dryers, whereas the presently-known alkalinity method is not applicable for WD. Additionally, as this aspect has never been mandatory to be declared, it will be difficult to set a minimum requirement due to the lack of data. The introduction of a minimum requirement in rinsing will ensure that the programmes are not declared to have a short duration just by removing the rinsing phase but it would mean an additional testing effort for manufacturers and also market surveillance authorities.

11.9. Spinning drying efficiency

Currently the spinning drying efficiency is measured throughout the weighted remaining moisture content (D) as follows

$$D_c = [A \times D_{t,60,full} + B \times D_{t,60,\frac{1}{2}load} + C \times D_{t,40,\frac{1}{2}load}]$$

Where;

$D_{t,40,full}$ is the residual moisture content for the standard 60°C cotton programme at full load, in percentage and rounded to the nearest whole per cent;

$D_{t,60,\frac{1}{2}load}$ is energy consumption of the standard 60°C cotton programme at half load in percentage and rounded to the nearest whole per cent;

$D_{t,40,\frac{1}{2}load}$ is energy consumption of the standard 40°C cotton programme at half load in percentage and rounded to the nearest whole per cent;

This value is displayed on the Energy Label, but - for the time being - no minimum requirements on the spin-drying performance have been set. The spin-drying performance of the washing machines has been gradually improved, and via this process, the worst performance classes have progressively been phased out. Current spin-drying technologies are mainly clustered in the three top Energy Label classes (i.e. A, B

and C). The distribution of the rated spin-drying performance in the CECED database 2015 is shown in Table 14.

Table 14: Distribution of the washing machines regarding the spin drying performance index. (Source: CECED database 2015)

	A	B	C	D	E	F
Washing machines	15%	60%	21%	3%	1%	0%

The importance of the spin drying performance (remaining moisture content RMC) is related to the subsequent drying process. The better the laundry is spun, the less water it contains and the faster and with less energy demand goes drying– in case of a tumble dryer being used.

The spin drying efficiency not only depends on the maximum spin speed (rpm) but also on the drum size (larger drums cause higher centrifugal forces at the same spin speeds, compared to smaller drums). According to the review study, models with 1000 and 1200 rpm eliminate half the humidity from the clothes, whereas machines with 1400 rpm eliminate 60% of this humidity. However, these additional 200-400 rpm might not be particularly useful (if they do not achieve further drying of the clothes, e.g., in a very humid place), and instead contribute to more wrinkling of the laundry (and hence the possible need for more energy-intensive ironing). Additionally, even though the use of a tumble dryer is an increasing observed trend, most laundry is still dried in the outside air/ on a line, and high spin speeds are only recommended when using a tumble/washer drier.

Spin drying efficiency is closely connected to the mechanical dimensioning of the appliances, and therefore offers a possibility of differentiating between types and modes. The introduction of a strict minimum requirement for the spin drying efficiency (or remaining moisture content (RMC)) of the testing programme(s) would limit such differentiations. Therefore, it is proposed not to include an Ecodesign requirement on spin drying efficiency, but instead to maintain this information as a requirement to be displayed on the Energy Label (as currently done). Additionally, it is proposed to include a recommendation in the booklet of information indicating that if subsequently a tumble-drying or washer dryer will be used by the consumer post-wash, then the higher spin speed is recommended, whereas if outside line-drying is going to be used, a lower spinning speed is recommended.

The declared value of the spin drying efficiency would, however, be modified to be in accordance with the proposed EEI. This means that the 40°C cotton programme will become the testing programme for the spin drying efficiency, as shown in the following equation

$$D_c = [A \times D_{t,40,full} + B \times D_{t,40,\frac{1}{2}load} + C \times D_{t,40,\frac{1}{4}load}]$$

Where;

$D_{t,40,full}$ is the residual moisture content for the 40°C cotton programme at full load, as a percentage rounded to the nearest whole per cent;

$D_{t,40,1/2load}$ = energy consumption of the 40°C cotton programme at half load, as a percentage rounded to the nearest whole per cent;

$D_{t,40,1/4load}$ = energy consumption of the 40°C cotton programme at a quarter of the load as a percentage rounded to the nearest whole per cent;

These results are no longer to be included in the energy label, but are to be provided in the product information sheet.

Annex 4 Other ecodesign requirements related to the performance of the washing machines.

11.10. Booklet of instructions

Most of the current requirements for the booklet of instructions provided by the manufacturer are proposed to remain in place, sometime including some modifications. The proposed requirements are:

- a washing cycle which is able to clean normally soiled cotton laundry declared to be washable at 40 °C or 60 °C, together in the same cycle. This programme shall be indicated as 'cotton 40 °C'. The name 'Cotton 40 °C' shall be used exclusively for this programme. Other programme indications displayed together with the term '40 °C' for normally soiled cotton laundry declared to be washable at 40 °C and 60 °C such as 'normal', 'daily' or 'standard' that could divert the end user from using 'cotton 40 °C' shall *not* be used. NB Only in those cases where the programme has a better performance than the 'cotton 40°C' programme are additional indications permitted to be displayed.
- the 60°C cotton programme, referred as 'cotton 60°C' programme, shall reach at least 45 °C in the laundry core, and the time that the maximum temperature is maintained should be communicated
- the power consumption of the off-mode, left-on mode and delay start
- indicative information on the programme time, remaining moisture content, energy and water consumption for the main wash programme at full or partial loads; or both
- information on the maximum temperature reached by the main wash programmes
- recommendation on the type of detergents suitable for the various washing temperatures
- recommendation on the spin speed to be used depending on the subsequent drying process such as tumble-drying or outside line-drying.
- information on the hot fill option, including how the benefits of this filling can be realised, and under which circumstances this option can be productive and counterproductive
- instructions for the user to perform maintenance operations for the purpose of ensuring durability, in addition to any instruction automatically delivered by the appliance when equipped with this feature.

11.11. Washing cycle at 20°C

The current requirement on the general availability of a 20°C cycle will be kept. This programme shall clearly be identifiable on the programme selection device of the household washing machines or the household washing machines display, if any, or both

11.12. Arrow for identifying the testing programmes

The use of an arrow for identifying the standard programmes was introduced later on through a Commission Decision (2012/C 206/05). This Decision proposed that to facilitate the clear identification of the relevant standard cotton programmes or programmes setting(s) on the programme selection device of the household washing machine or the household washing machines display, an arrow with or without indication of the temperature should be used.

These symbols were presented as a transitional measure that would ultimately be replaced by symbols provided in harmonized standard(s). However, this replacement has not yet happened due the lack of a related official standardisation request.

Manufacturers made a great effort to adapt their control panels to this decision, and included it on all products that enter the EU market. However, after approximately 5 years, the consumer surveys undertaken and reported on in the review study demonstrated that consumers in general do not understand the meaning of this symbol.

For this reason, and although manufacturers made a great effort to adapt their products accordingly, it is proposed not to keep this measure.

11.13. Time indications, restrictions or time caps on programmes

As commented in the review study, the excessive duration of the standard programmes dissuades consumers from selecting them. Therefore, in this revision, several measures are proposed in order to avoid, or even to reverse the observed tendency of manufacturers to use longer standard programmes in their equipment and functionality designs.

The possible measures to be implemented may be divided into two groups:

- a) Informative measures which aiming at providing a more transparent indication of the programme time to consumers (e.g. information about the time duration on the Energy Label, and in the booklet of instructions)
- b) Modifying the calculations of the EEI to include a duration as an additional parameter; and
- c) Restrictions or limitations to the duration of the testing programmes (e.g a time cap)/

11.13.1. Informative measures on the duration of the testing programmes

Most stakeholders have agreed on a more transparent indication of the programme time on:

- the label,
- the booklet of instructions,
- the display, when this feature is present on the machine.

If the programme duration becomes mandatorily indicated on the label, this declaration would in theory create competitive conditions for machines with similar technologies, as it may influence the purchase decisions of the consumers. It might be anticipated that manufacturers would then either bring on to the market machines with shorter programmes but higher energy consumption, or machines with lower energy consumption but which use more time to carry out the task.

The ideal competition conditions of time-energy described above are theoretical, but some stakeholders have indicated that they do not believe that the market will behave ideally, and instead suggest that this measure will not be as effective as proposed.

Some of the open questions that remain on the table with regard to this measure are, for example, how to calculate the time displayed on the label: e.g. as an average of the testing programmes; whether it should be the shortest or the longest programme; and how to communicate to consumers the duration of the washing programme, e.g. under the hh:mm format per cycle, or whether it would be better in the format of citing minutes/cycle.

This measure can be combined with other informative measures, such as the inclusion of the programme time in the booklet of instruction of the main programmes, or displaying the time information on the display when this feature is present on the machine.

11.13.2. Inclusion of duration in the EEI as an additional parameter

As a potential newly-introduced option, it is proposed that time could be introduced as an additional parameter in the energy efficiency index (EEI) calculation formula. This would be achieved by introducing an additive coefficient to the formula that provides a bonus to programmes with a duration shorter than 180 minutes (3 hours), and a malus to programmes exceeding 180 minutes. The new EEI formula would then potentially be constructed as shown below:

$$EEI_c = \frac{1}{SE_c} \times \left[A \times E_{t,40,full} + B \times E_{t,40,\frac{1}{2}load} + C \times E_{t,40,\frac{1}{4}} \right] \times p_T + \frac{1}{180} \times \left[A \times t_{t,40,full} + B \times t_{t,40,\frac{1}{2}load} + C \times t_{t,40,\frac{1}{4}} \right] \times p_t$$

Where

$t_{t,40,full}$ is the duration of the 40°C cotton programme at full load

$t_{t,40,1/2load}$ is the duration of the 40°C cotton programme at half load

$t_{t,40,1/4load}$ is the duration of the 40°C cotton programme at quarter-load

p_T is the weighting factor of the temperature term

p_t is the weighting factor of the time term

and where $p_T + p_t = 1$

This modification would disincentive manufacturers to pursue test programmes with a long duration, as these would not obtain better energy indices, and would instead incentivise the development of energy-saving programmes that are also shorter than 3 hours. On the one hand, this strategy is less transparent than the plain declaration of the programme time on the Energy Label, and it also takes away from the consumer the decision of going for 1) a short but less energy efficient programme, or 2) a long but more energy-efficient programme. On the other hand, it is a pragmatic approach that addresses the repeatedly reported user survey results that indicate that consumers do not understand how longer programmes can be energy-saving. This approach would somehow help consumers not have to make this trade-off decision, which is well-known to washing machine experts, but not the layman.

This measure, i.e., proposing the introduction of the time in the EEI formula as an additional parameter, may be combined with all other measures if considered necessary, e.g., the provision of information on the Energy Label and in the booklet of instructions, or the introduction of a time restriction as explained below.

11.13.3. Time restrictions

Finally, the type of measure that can be introduced is a time restriction, such as a time cap. Stakeholders suggested that providing information to consumers may not be enough to ensure that competition takes place amongst manufacturers, within the range that is acceptable to consumers (e.g. 2:30 h or 3 h), and that therefore a time cap on washing machine programmes is needed. This measure would, however, restrict the differentiation of machines, although the real dimension of this possible restriction would only be able to be seen once real test values with the new standard measurement protocol became available. In the worst case scenario, if the time range is too restricted, most of the machines will be clustered around one or two Energy Label efficiency classes, and consequently the strength of the Energy Label as a communication instrument would then be weakened, as and until technology development stretched the range.

Table 15 summarises the options:

Table 15: Possibilities for shorter the duration of testing programmes

OPTIONS FOR SHORTENING THE TIME PROGRAMME DURATION OF TESTING PROGRAMMES		
Option	Sub-option	Comments
Informative measures	On the Energy label	- will influence purchase decisions - as a single number will not be fully transparent to consumers
	On the display of the machine	- does not influence purchase decisions - may dissuade consumers from selecting the standard testing programmes from amongst the options available
	On the fiche	- may influence the purchase decisions - information may be more detailed
	On the booklet of instructions	- does not influence the purchase decisions - may persuade the consumers from selecting the washing cycles that comprise the standard testing programmes - is the more transparent option
Inclusion of the time in the EEI equation		- the EEI does not only reflect the energy consumption. It would need to be renamed - creates a completely new playground for competition. Time becomes more relevant as a competition parameter among the manufacturers - testing needed before establishing the new energy efficiency classes
Time restrictions		- if the time restriction is too restrictive, product performance differentiation among the models will be more difficult

11.14. Information on hot-cold fill option

There are washing machines and washer-dryers that have the possibility to be connected directly to the hot water tap. In practice, this option is rather seldomly utilised, although a direct connection to the hot water tap could be beneficial in terms of overall electricity savings. With better consumer information, this option might be used more often, since many consumers might not be aware of this electricity-saving option.

The complexity of this information and the limited room on the Energy Label might lead to it having no effect on the market in the end, if this information is provided by this means. An icon may be difficult to understand, and to be implemented by the consumers. For this reason, it is proposed to provide mandatory information on the hot fill option in the booklet of instructions of the washing machine or the washer-dryer.

The hot fill option has also some drawbacks. For example, an overall trend to lower washing temperatures is already in place and the hot fill feature might not be so effective, or hot rinsing may result in a energy wastage. For some washing needs (e.g. avoiding denaturation of proteins or avoiding damage to some textiles) the use of hot water can be counterproductive (e.g. blood stains may become fixed to textiles if higher temperature washing is used). Also, the temperature at the tap should not exceed 60 °C, to ensure full protection of the functioning of the appliance. Hence; additional safety devices would need to be installed, to ensure this limit is respected.

In addition, it must be noted that any benefits that may accrue depend on the type of heating/ hot water system in the house (e.g. renewable sources, natural gas, etc) and the length of the pipe. That is, in certain cases, e.g. hot filling linked to inefficient hot water generating systems may actually increase energy consumption.

11.15. Recommendation on the loading of the machine

The consumer information requirements are extended, by now including information that loading the machine up to the maximum capacity indicated by the manufacturer for the respective programmes will contribute to saving energy and water.

11.16. Other 40°C cotton programmes

Other programmes designed for cleaning normally soiled cotton laundry may be introduced, if two conditions are fulfilled: firstly, the programme names must not create confusion regarding the standard '40°C cotton' programme; and secondly, for their inclusion to be allowed, such programmes must be more efficient than the standard washing cycle testing programme, in terms of energy consumption and water use, for that type of cotton laundry. Names such as "normal" or "standard" should not be used on the machine.

11.17. Minimum temperature for the testing cotton programmes.

Generally speaking, current standard programmes do not reach the temperatures which are specified in the programmes' names. This fact may bring some environmental benefits but it is not well accepted by the consumers.

The fact that current standard programmes do not actually reach 40°C or 60°C would allow consumers to fill washing machines more, i.e., to make full use of the higher load capacities, by combining separate loads which can be washed at 40°C or 60°C. However a good communication strategy would be required to inform consumers of this probably surprising fact regarding the actual temperatures reached, and subsequently regarding its possible washload/ environmental benefits.

On the other hand, to address hygienic issues it still would be necessary to guarantee that the declared temperature of some programmes, e.g. 60°C cotton is really reached. User surveys indicate a relatively frequent (17%, not including standard cotton 60 °C) use in Europe of programmes with high temperature ($\geq 60^\circ\text{C}$), which one can interpret as programmes deliberately selected for the purpose of hygienisation (e.g. bed linen, towels, textile nappies). For these reasons, it is proposed that only in the case of the testing programme 60°C cotton programme, a minimum temperature will be required.

According to the review study, Honisch et al (2014) checked the combinations of chemistry, temperature and time of washing that are able to remove an array of different pathogens from laundry. A key finding of this review was that most pathogens are deactivated without bleaching if the temperature is $>52^\circ\text{C}$ for >15 mins, or $>47^\circ\text{C}$ for >90 mins. However, the study highlighted that due to the lack of test conditions it was extremely difficult to define the uncertainty of those values.

Based on this discussion, it is proposed that as a minimum, machines shall have efficient programmes at higher temperatures for cotton in which a temperature of at least 45°C is reached in the core of the laundry and it should be maintained for some time (to be communicated). A minimum energy efficiency requirement is also proposed for the energy consumption of this programme.

Additionally, for some of the alternatives of EEI it is necessary to set up a minimum temperature for the testing programmes. This temperature is proposed to be 30°C in the core of the laundry. Reaching this temperature it is expected that the testing programmes will shorten their duration.

An ecodesign requirement that makes mandatory the provision of information in the booklet of instructions and/or on the machine's display (when available) on the maximum temperature reached by clothes in the main programmes will be proposed. So consumers would be able to choose between a)

wash most environmental friendly or b) (in certain circumstances) wash hygienic and be sure to eliminate pathogenic germs and/or parasites.

Annex 5: Other Ecodesign requirements related to the performance of washer-dryers

Spinning drying efficiency

The declared value of the spin drying efficiency would however be modified to be in accordance with the proposed C (specific energy consumption of the continuous wash&dry cycle). This means that the 40°C cotton programme will become the testing programme for the spin drying efficiency, as shown in the following equation:

$$D_c = \frac{[3 \times D_{t,40,full} + 2 \times D_{t,40,\frac{1}{2}load}]}{5}$$

Where:

$D_{t,40, full}$ is the residual moisture content for the complete operation cycle of a household washer-dryer, 'cotton 40 °C' programme in combination with drying to cupboard dry at full load, in percentage and rounded to the nearest whole per cent;

$D_{t, 40, \frac{1}{2} load}$ is the residual moisture content for the complete operation cycle of a household washer-dryer, 'cotton 40 °C' programme in combination with drying to cupboard dry at full load, in percentage and rounded to the nearest whole per cent;;

Annex 6: Resource efficiency requirements

Resource efficiency requirements serve three main purposes:

1. To ensure that the expected durability of appliances as designed is met, and that, *at the moment of purchase*, the consumer is well informed of what to expect regarding the support which will be made available over the lifetime of the product from the manufacturer concerned.
2. To support more efficient recycling, via introducing requirements that help recyclers to comply better with the WEEE Directive (2012/19/EU), by providing information relevant to the depollution, dismantling and sorting operations. This will result in higher quality output "waste/ secondary resources" streams.
3. To support a level playing field in the market for product repairs, to the benefit of consumers. Some current aftermarket practices of manufacturers restrict or hinder the market of the independent repair sector, increasing the final cost of repair to consumers. It is proposed to introduce requirements that suppress/ eliminate such practices.

These requirements align with and expand ecodesign requirements adopted so far, and underpin the objectives of Commission Communication "Towards a circular economy: a zero waste programme for Europe", which aims at establishing a common and coherent EU framework to promote the circular economy.

The overall objective is that, in consultation with affected stakeholders, the proposed requirements should result in relatively small additional costs to manufacturers, while delivering proportionally larger cost reductions and improved efficiencies for the repair and recycling sectors, together with associated important benefits to consumers. These elements will be studied in detail during the forthcoming Impact Assessment appraisals.

The proposed resource efficiency ecodesign requirements are detailed below.

11.18. 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 activities that are necessary to undertake during the use phase of the washing machines/ washer-dryers. A second objective of this measure is to encourage preventative maintenance, to thus avoid unnecessary repair operations that arise mainly due to poor maintenance by users. In some Member States – in general – or at points of sale, information may be added, when it complements or replaces the information contained within the booklet.

This requirement also includes the requirement to communicate the period during which, or date until, the spare parts necessary for the use and repair of the machine will be available, together with the maximum delivery time to the consumer/ independent repair facility of such parts. These parameters are set as follows, as mandatory requirements: (a) the minimum availability of spare parts is set as 7 years from the manufacture of the product; (b) the maximum delivery time of the spare parts is set at three weeks, with an exception solely for *force majeure*.

11.19. 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 this 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 F-gas marking shall be on the back panel. The capacitor marking shall be on the capacitor itself. Both markings shall be identifiable and legible to the naked eye from a distance of c. 2 m. The marking must be indelible and durable for at least the average lifetime of the appliance. Standardisation bodies are given the task of defining the adequate material characteristics, size, shape, etc. for the purpose described.

11.20. 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 the depollution, dismantling and sorting operations. This will result in higher quality output streams. It is proposed to make a requirements that access to and extraction of the components of concern (WEEE Annex VII, 2012/19/EU) must not necessitate any tools that are either proprietary or not commonly available, in order to disassemble the fixings of these WEEE-related components.

11.21. Spare part availability time horizon declaration

The consumer shall be informed 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 for their appliances, and can thus make them available. Sales of spare parts is normally a lucrative business, since spare part prices normally have a high markup.

Verification of declarations is only partial, as this requirement is targeted towards the future, and not when the product is placed on the market. Only the presence of the declaration can be undertaken at the moment of inspection. The fulfilment of the content of the declaration is not intended to be verified.

11.22. Spare part maximum delivery time

This requirement completes the previous requirement. Spare part warehouses shall not be located overseas if this hinders the delivery of the spare parts. The objective of the delivery maximum time horizon is that delivery of spare parts must not jeopardise the choice of the consumer to undertake the repair.

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

11.23. Access to Repair and Maintenance Information (RMI)

The objective of this requirement is twofold:

1) to promote design for reparability, and to ensure that lifetime is not shorter than designed for, thus avoiding unnecessary environmental impacts

2) to strengthen open markets for repair. Repair services shall not be beholden to, or be "hostages" of OEM repair services, i.e., where the lack of spare parts acts as a barrier to swift and cost-efficient repair. Repair periods and costs shall be at their optimal minimum for the consumer, regardless of the provider of the service. Some OEMs currently hinder access to the information and tools. Captive and monopolistic markets have to be avoided, as they result in higher costs for consumers.

After-sales services are a competitive arena that is seen by some OEMs as an option for differentiation between manufacturers. However, to allow a fair and transparent differentiation of products on the market, basic rules are necessary, by means of minimum Ecodesign criteria that ensure market transparency. Availability for professionals upon registration/certification shall be ensured, and training must be offered openly and affordably.

For the above RIM aspects, enforceability and control mechanisms are still to be developed.

Annex 7 Energy labelling requirements for washing machines

The 2017 Energy Labelling "framework" regulation requires that the EU Energy Label Class A be left empty on an Energy Label's revision, or when a new EU Energy Labelling policy enters into force.

11.24. Energy efficiency classes (values calculated based on the proposal, using loading factors)

As of February 2017, the most efficient 8kg appliance on the market was an advanced technology (improved detergent mixing and improved motor) machine with a declared energy consumption of 97 kWh/year (EEI = 20.5). Using the declared value, but estimating the equivalent energy consumption for a 7 kg capacity machine (97 kWh/year) and respecting the request to leave Class A empty, this would result in a medium energy consumption of 85kWh/year for EU Energy Label Class B. If one were to use 20% EEI differences for consecutive EU Energy Label classes, this would lead to the following Energy Label class distribution pattern for washing machines, under the previously-mentioned Scenario 2b2:

Table 16: Proposed energy efficiency classes for the Energy label for washing machines

Label class	Scenario 2b2 (kwh/a)		Proposed EEI
	Min	Max	
A		77	EEI < 30
B	77	95	30 ≤ EEI < 43
C	95	113	43 ≤ EEI < 59
D	113	134	59 ≤ EEI < 80
E	134	159	80 ≤ EEI < 105
F	159	189	105 ≤ EEI < 135
G	189	224	EEI ≥ 135

Similar values are obtained if the estimated energy consumption values from the CECED database 2015 are considered. These values are plotted in Figure 37. Considering that the most efficient washing machines barely reach an EEI = 30 in any of the plotted capacities, this value is proposed as the limit to be classified in Class A. NB It is important to note that the difference between EEI classes is kept at 30-40% (i.e., higher than the proposed tolerance levels).

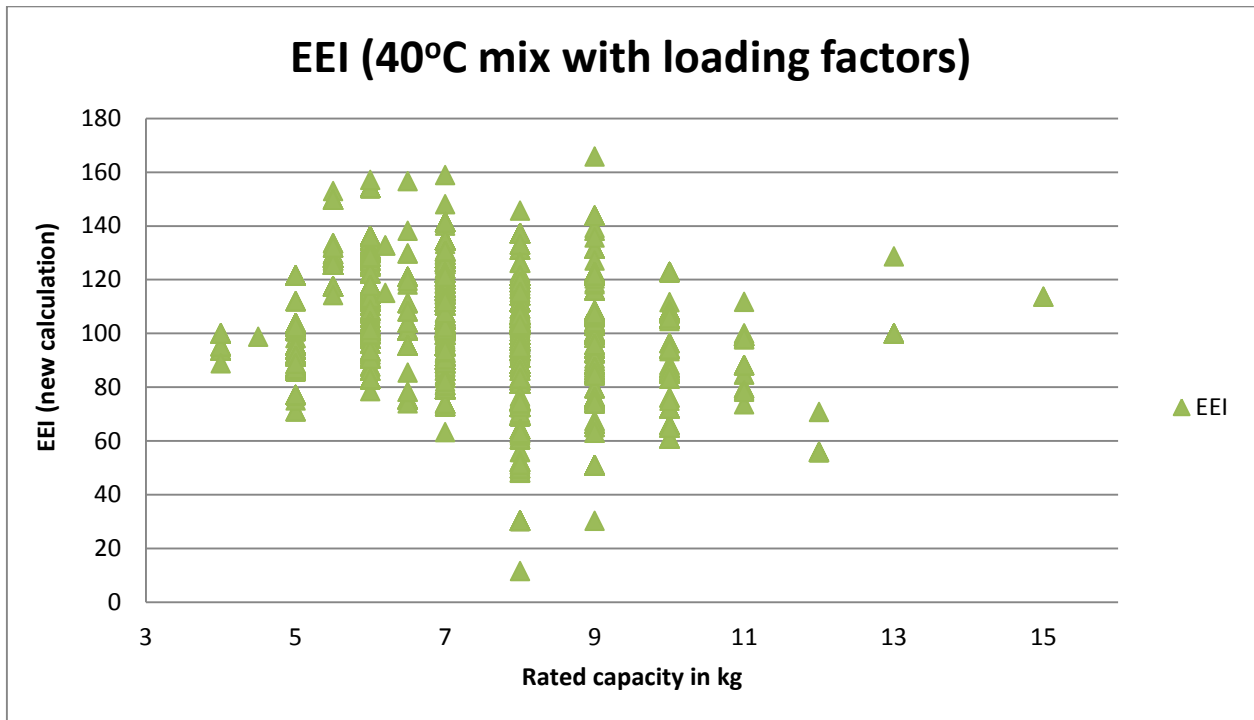


Figure 37: Estimated EEI values from the CECED database 2015

A detailed investigation of the differences will need to be undertaken in the forthcoming impact assessment, to assess whether or not the labelling changes should be made in combination with stricter Ecodesign requirements. Further, the inclusion of the programme duration of the cotton 40°C programme in the EEI calculations would most likely change the distribution and ranges of the classes. The inclusion of the information of the duration of the 40°C cotton programme on the label could be sufficient to prevent manufacturers from extending their cycle designs to take advantage of this testing programme. Hence, there is a risk that Energy Label Class A may not be populated in the coming 8 years, as the intentions of the revised Energy Labelling rules mean that there should not be a (possibly artificially induced) sharp apparent decrease of energy consumption via manufacturers' "gaming" strategies with the Energy Label. .

11.25. Spin drying efficiency classes

Currently the spin drying efficiency classes follow the same pattern as the Energy Labelling efficiency classes. Spin drying efficiency classes range from A to G, A being the best performing class. It is proposed to keep this format but, however, to re-calculate the values in accordance with the revised testing cycles. This information is proposed to be delivered throughout the information product sheet instead of the Energy Label. Direct access to the information product sheet will be possible by means of the QR code.

11.26. Information on the Energy label

The current EU Energy Label for washing machines provides the following information:

- a) supplier's name or trade mark
- b) supplier's model identifier, meaning the code, usually alphanumeric; which distinguishes a specific household washing machine model from other models with the same trade mark or supplier's name.




With regard to the performance of the machine the following is needed:

- a) the Energy Label efficiency class, determined in accordance with the current combination of standard cotton programmes at 40°C and 60°C for full and half loads.
- b) weighted annual energy consumption (AE_c) in kWh per year, rounded up to the nearest integer
- c) weighted annual water consumption (AW_c) in litres per year, rounded up to the nearest integer
- d) rated capacity, in kg, for the standard 60°C cotton programme at full load or the standard 40°C cotton programme at full load, whichever is lower
- e) the spin drying efficiency class
- f) airborne acoustic noise emissions during the washing
- h) airborne acoustic noise emissions during the spinning phase for the standard 60°C cotton programme at full load, expressed in dB(A) re 1 pW, rounded to the nearest integer.

Regarding water consumption and energy consumption, the user survey of the review study showed that consumers prefer these values to be indicated per cycle instead of per year. Therefore, it is proposed to indicate the consumption per cycle instead of per year on the revised EU Energy Label

Additionally, it is proposed that the noise emissions should be displayed on the Energy Label both as a digit (integer number of dB(A)) and as noise classes, similar to the regulation for the labelling of tyres (Regulation (EU) No 1222/2009). Three noise classes are proposed, which would correspond to "very silent", "normal" and "loud", which would lead to a classification as follows:

Table 17: Proposed acoustic airborne emission classes for the washing and spinning of the washing machines

	Acoustic airborne noise emission classes		
	Silent 	Normal 	loud 
Washing process dB(A)	$n \leq 51$	$51 < n \leq 57$	$n > 57$
Spinning phase dB(A)	$n \leq 74$	$74 < n \leq 77$	$n > 77$

Finally, one of the possible measures to reverse the current tendency towards longer durations of the programmes used for testing is to include the information on the duration of the testing programme on the energy label for washing machines. This measure can be easily combined with others to become more effective.

The inclusion of the duration of the testing programmes can be done either as a weighted average of the duration of the testing programmes and loadings, or via reporting the longest duration among all the testing programmes and loadings. In the first case, the weighted average duration of the testing programme would be calculating according to the following equation:

$$t_{40C} = [A \times t_{40,full} + B \times t_{40, \frac{1}{2}load} + C \times t_{40, \frac{1}{4}}]$$

Where:

- t_{40C} is the weighted average time duration of the testing programmes
- t_{40,full} is the time duration of the 40°C cotton programme at full load;
- t_{40,1/2} is the time duration of the 40°C cotton programme at half load;
- t_{40,1/4} is the time duration of the 40°C cotton programme at a quarter-load;

Considering these changes, the following information is proposed to be displayed on the revised Energy Label::

- a) supplier's name or trade mark
- b) supplier's model identifier, meaning the code, usually alphanumeric; which distinguishes a specific household washing machine model from other models with the same trade mark or supplier's name.

Regarding the performance of the machine, it is proposed that the following must be displayed:

- a) the energy efficiency class determined on the 40°C cotton programmes in accordance with a combination of full, half and quarter loads.
- b) weighted energy consumption (E_c) in kWh per cycle, rounded up with two decimals
- c) weighted water consumption (W_c) in litres per cycle, rounded up with two decimal
- d) rated capacity, in kg, for the 40°C cotton programme at full load,
- e) the weighted average time duration for 40°C cotton programme at full, half and quarter-load.
- f) a QR code that gives access to the product information sheet of the product

Annex 8 Energy labelling requirements for washer dryers

11.27. Energy efficiency classes

As of February 2017, the most efficient 8 kg appliance on the market was a heat-pump equipped machine with a declared energy consumption of 734 kWh/year (C = 0.41 kWh/kg). Using the declared value, and if one is to respect the 2017 Energy Labelling regulation instruction to leave the revised Energy Classes A and B empty, this would result in a maximum EEI value of 0.41 kWh/kg for an Energy Label class C, post-revision. If one were to use approximately 20 % differences for consecutive Energy Label classes, this would lead to the following Energy Label class distribution. (Note that on the left side are the values considering a result with a standard 60°C cotton testing programme for the washing process, and on the right side are the values considering a testing with a normal 40°C cotton programme).

Table 18: Proposed energy efficiency classes for the Energy label for washer dryers

Label class	Scenario 5b1		Proposed values	
	C min	C max	C min	C max
A		0.29		0.29
B	0.29	0.37	0.29	0.37
C	0.37	0.47	0.37	0.48
D	0.47	0.57	0.48	0.58
E	0.57	0.70	0.58	0.71
F	0.70	0.85	0.71	0.86
G	0.85	1.04	0.86	1.06

A detailed investigation of the differences would be required during the impact assessment, and an evaluation of whether or not these Energy Labelling revisions should be made in combination with stricter Ecodesign requirements.

11.28. Information on the Energy label: Washer-Dryers




The current EU Energy Label for washer-dryers includes the following information:

- a) Supplier's name or trade mark
- b) Supplier's model identifier
- c) The EU Energy Labelling efficiency class of the model.
- d) Energy consumption in kWh per complete operating (washing, spinning and drying) cycle using the standard 60°C cotton cycle and 'dry cotton' drying cycle
- e) Energy consumption in kWh per washing (washing and spinning only) cycle using the standard 60°C cotton cycle and 'dry cotton' drying cycle
- f) Washing performance class
- g) Maximum spin speed attained for the standard 60°C cotton cycle
- h) Capacity (in kg) of appliance for the standard 60°C cotton cycle (without drying),
- i) Capacity (in kg) of appliance for the 'drying cotton' (drying) cycle
- j) Water consumption, in litres, per complete operating (washing, spinning and drying) cycle using the standard 60°C cotton cycle and 'dry cotton' drying cycle
- k) When applicable, noise during washing, spinning and drying cycle using the standard 60°C cotton washing cycle and 'dry cotton' drying cycle

Due to the proposed modifications in the testing cycle, the requirement of the provision of information for washer-dryers would read:

- a) Supplier's name or trade mark
- b) Supplier's model identifier
- c) The energy efficiency class of the model.
- d) Energy consumption in kWh per complete operating (washing, spinning and drying) cycle using a continuous wash&dry cycle (if not available an interrupted wash&dry cycle to be used) and a 40°C cotton cycle for washing
- e) Capacity (in kg) of appliance for continuous wash&dry cycle (or interrupted wash&dry cycle, if not available)
- f) Water consumption, in litres, per complete operating (washing, spinning and drying) cycle using a continuous wash&dry cycle (if not available, an interrupted wash&dry cycle to be used), and a 40°C cotton cycle for washing
- g) Time programme duration of the complete dry and wash cycle
- h) A QR code that gives access to the product information sheet of the product.

Table 19: Proposed acoustic airborne emission classes for the washing, spinning and drying phases of the washer-dryers

	Acoustic airborne noise emission classes		
	Silent 	Normal 	loud 
Washing process	$n \leq 51$	$54 < n \leq 57$	$n > 57$
Spinning phase	$n \leq 74$	$74 < n \leq 77$	$n > 77$
Drying phase	$n \leq 59$	$59 < n \leq 64$	$n > 64$

HOW TO OBTAIN EU PUBLICATIONS

Free publications:

- one copy:
via EU Bookshop (<http://bookshop.europa.eu>);
- more than one copy or posters/maps:
from the European Union's representations (http://ec.europa.eu/represent_en.htm);
from the delegations in non-EU countries (http://eeas.europa.eu/delegations/index_en.htm);
by contacting the Europe Direct service (http://europa.eu/eurodirect/index_en.htm) or
calling 00 800 6 7 8 9 10 11 (freephone number from anywhere in the EU) (*).

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

Priced publications:

- via EU Bookshop (<http://bookshop.europa.eu>).

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.



EU Science Hub
ec.europa.eu/jrc



@EU_ScienceHub



EU Science Hub - Joint Research Centre



Joint Research Centre



EU Science Hub