Document for the meeting of the Consultation Forum of 31/03/2022
PROPOSAL FOR A NEW FORMULA FOR VACUUM CLEANERS – 28/02/2022

Corrections on 17/03/2022 highlighted in dark red:
1) AE formula on page 4; 2) footnote 11; 3) in Table 2, rows 4 and 6

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Following news in standardisation and legislation, comments from the last meeting of the Consultation Forum on the topic (in 2019) and bilateral talks, an updated proposal for the ecodesign and energy labelling formula for vacuum cleaners, is here presented for discussion.

BACKGROUND

Following the Ecodesign Working Plan 2016-2019[1], the review clause in the current ecodesign Regulation (EU) 666/2013[2] and the review clause in the later annulled energy labelling Delegated Regulation (EU) 665/2013[3] on vacuum cleaners (VC), in 2017 the Commission launched a review study. The review was to investigate verification tolerances, extension of the scope to full-size battery-operated VC and whether energy consumption, dust pick-up (*dpu*) and dust re-emission could be based on a partly loaded rather than an empty receptacle[4]. The latter became especially relevant with the annulment of the energy label regulation as a result of the verdict of the General Court in Case T-544/13 of Dyson v Commission of November 2018[5].

A first course of action was discussed in a Consultation Forum (CF) meeting in February 2019, where it was confirmed to address ecodesign and energy labelling measures together. Building on the results of the review study, the Commission presented a draft proposal for those measures to the CF in October 2019.

Meanwhile, the standardisation working groups have dealt with Round Robin Tests (RRTs) to make the testing closer to real-life conditions at acceptable reproducibility levels.

Mid-2021 the Commission launched its impact assessment process, taking into account stakeholder comments on the 2019 Commission proposal, the results from tests in the standardisation working groups, bilateral talks with various stakeholders and the latest insights and measures regarding circular economy measures.

Re-cap of the Commission proposal of October 2019

The ecodesign proposal of October 2019:

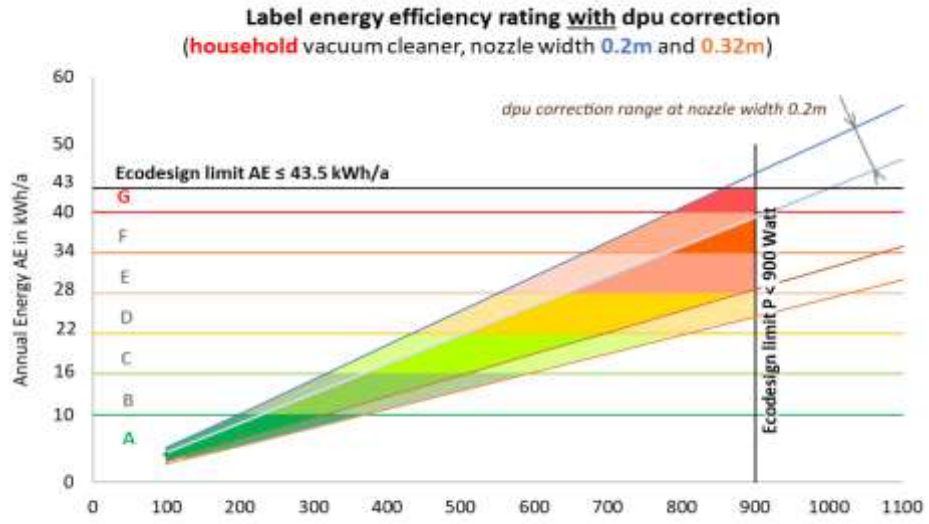
[1] https://ec.europa.eu/energy/sites/ener/files/documents/com_2016_773.en_.pdf
[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R0666
[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R0665
[4] The Review Study ran from May 2017 till July 2019, establishing that the regulations have been very successful in reducing the power consumption from over 1600 W before 2014 till about 700 W in 2018. The ecodesign rules set a minimum power limit in 2017 of 900 W and from the point of view of LLCC, the review study concluded that the limit could not be pushed any further. The energy label was an important commercial incentive to reach and go quickly beyond the ecodesign minimum.
[5] The General Court ruled in favour of Dyson, because '…for the method adopted by the Commission to accord with the essential elements of Directive 2010/30, two cumulative conditions must be met. First, in order to measure the energy performance of vacuum cleaners in conditions as close as possible to actual conditions of use, a vacuum cleaner's receptacle must be filled to a certain level. Secondly, the method adopted must satisfy certain requirements concerning the scientific validity of the results obtained and the accuracy of the information supplied to consumers.' It decided that these conditions were not both met and thus annulled the energy labelling regulation for vacuum cleaners.

- kept the energy efficiency limits of Regulation (EU) 666/2013[6], because there is no Least Life Cycle Cost (LLCC) gain in setting more ambitious limits;
- made cleaning performance criteria more ambitious[7];
- apart from dust pick-up (*dpu)*, proposed debris pick-up on carpet and hard floor, following the latest proposals in test standards*;*
- extended the scope to cordless VC (at more lenient performance and sound limits);
- as for circular economy, confirmed existing requirements for motor lifetime, hose oscillations[8] and a minimum battery life of 600 loading cycles and added rules on spare parts, repairability and recyclability.
- defined power input as 'operational' instead of 'rated'[9] and motion resistance no more than 40 N.

The energy labelling proposal of October 2019:

- kept a cleaning performance correction of the measured carpet dust pick-up (dpu_c) versus standard dpu_c of 0.8 and for hard floors proposed a debris pick-up (deb_{hf}), corrected against a standard value of 0.85;
- added the debris pick-up, in order to give more differentiation in the measurements.

Figure 1 shows the label classes from the 2019 proposal with a (light-coloured) border zone where the cleaning performance correction (e.g. standard *dpu*/measured *dpu*) may add up to half or a whole energy class at the same power consumption. The upper border represents the classification at 0.2 m nozzle width and the lower border represents 0.32 or more nozzle width.



Following the need to better reflect 'real-life' and be reproducible, energy and performance tests were to be based on three instead of five double strokes (starting with a forward stroke) and at partially loaded receptacle, using the manufacturer-declared *'minimum useful volume'* (*muv*) as a basis for reproducible load-assessment. More details are in Annex I.

A novelty in the 2019 proposals was to specifically include in the picture commercial VC[10].

[6] Maximum 43 kWh/a and max. 900 W for household VCs.

[7] Limits dpuc 75 instead of 70%; dpuhf 98% instead of 90%. New limits for debris pick-up on carpet and hard floor. All tests to be done with one single (universal) nozzle.

[8] Minimum motor life is 500h at partially loaded or 550h at empty receptacle. Minimum 40,000 hose oscillations without damage.

[9] To avoid possible circumvention and ensure that this is really the maximum power, because the test standard allows that on top of the 'rated' power input there can be an extra 'booster' power input.

NEW PROPOSAL (JANUARY 2022)

As for the scope, it is confirmed to check the option to broaden the scope to one or more of these types of VC: cordless/battery-powered[11], robot[12] and handheld vacuum cleaners.

As for the energy consumption, the proposal is to have the same formula for ecodesign and energy labelling.

Main difference with the October 2019 proposal:

- The cleaning performance is not in the formula. Instead, the minimum acceptable cleaning performance level is raised to the highest possible level as an entry point to be compliant to ecodesign. This is reflected in the *dpu* and *deb* minimum accepted levels. This is the same approach used for the ecodesign review in 2019 for washing machines and dishwashers.
- Instead, cleaning performance is included in a separate parameter S (= speed) to be calculated aside and to be shown on the label as m2/min

The table below gives the proposed ecodesign requirements for mains operated VCs with passive nozzle.

Table1. Summary of ecodesign requirements for vacuum cleaners

symbol	description	unit	required	verif.tolerance
AE	Annual energy consumption	kWh/a	≤ 43.5	4.35
P_{max}	Maximum operating power *P* (*mains*) or *Peff* (*bat*)	W	≤ 900	36
dpu_c	Dust pick up on carpet (*hh/pro* & *c/gp*)	%	≥ 75%	5%pt
dpu_{hf}	Dust pick up on hard floor (*hh/pro* & *hf/gp*)	%	≥ 95%	5%pt
deb_c	Debris pick up on carpet (*hh/pro* & *c/gp*)	%	≥ 85%	5%pt
$deb_{hf,hh}$	Household debris pick up on hard floor (*hh* & *hf/gp*)	%	≥ 85%	5%pt
$deb_{hf,\ pro}$	Commercial debris pick up on hard floor (*pro* & *hf/gp*)	%	≥ 70%	5%pt
dre	Dust re-emission	%	≤ 0,8%	0,012%pt
dB	Sound power level	dB(A)	≤ 80	2
F	Motion resistance	N	≤ 40	4
t_{motor}	Operational motor lifetime, empty or partially loaded	h	≥ 500 (part load) ≥ 550 (empty)	25
t_{hose1}	Durability of primary hose (bending cycles)	# cycles	≥ 40 000	100
t_{hose2}	Durability of secondary hose (stretching cycles)	# cycles	≥ 40 000	100
ET	Battery energy throughput	kWh	≥ 70	5

[10] There was a first attempt to have a formula that stresses the 'visible dirt removal', using heavy (brass) debris instead of the nylon debris of a machine typical for household use, and the speed of cleaning (in m²/min) which seems more important for typical customers of commercial VC (professional cleaning firms) than in a household setting.

[11] See **Table 2**. It is proposed not to define specific charge/discharge rates and depth of discharge but follow the manufacturer's instructions as the battery typology may be very different between models. Also we would set a minimum energy throughput Et and not (directly) the cycles.

[12] In 2018, cordless/battery-operated and robot vacuum cleaners (not currently regulated under ecodesign) represented 12% (37 million units) of stock in the EU and consumed about 9% of the total electricity used by vacuum cleaners. This is expected to grow to 126 million units, representing 40% of total EU energy consumption by vacuum cleaners in 2030. Despite the lack of suitable testing methods to measure their cleaning performance and efficiency, robot vacuum cleaners could come within the scope of ecodesign if we set requirements for low-power modes and resource efficiency. In general, for all types of appliances, standby/low-power modes need to be better regulated and resource-efficiency requirements tightened (notably regarding battery replacement and maintenance/operational lifetime of vacuum cleaners, including the durability of the hose).

The performance tests are to be conducted with three double strokes, universal nozzle for all tests, and partially loaded receptacle. The partial loading is based on grammes test dust per litre of declared 'maximum useful volume' (muv) of the receptacle.

The test for mains-operated VCs follows IEC 62885-2:2016, measuring the power intake during the test when the nozzle is moving at a constant speed of 0.5 m/s (1800 m/h), covering a floor-width equal to the nozzle-width B (in m). Hence the floor surface covered per hour is 1800B m². From the nozzle width B and average power intake P the average specific energy consumption SE per surface area in Wh/m² (single stroke) can be calculated as:

$SE = P/(1800B)$,

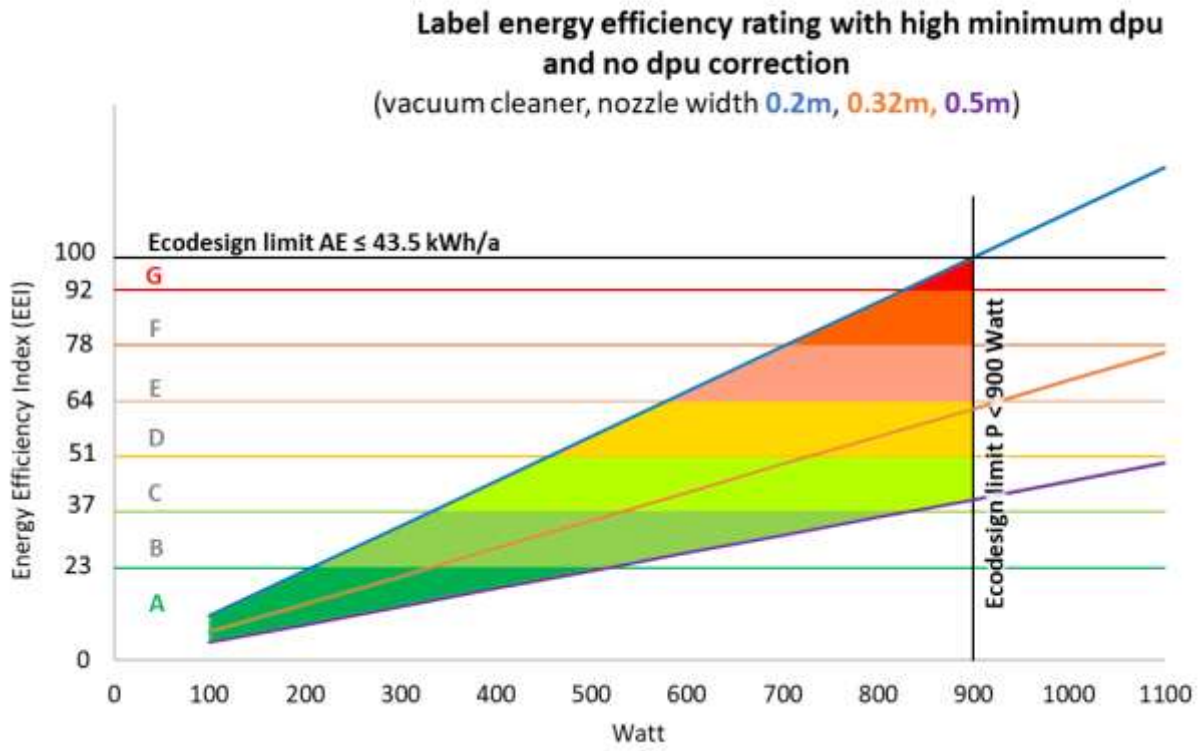
For an average annual usage it is assumed that the vacuum cleaner covers an area of 17400 m² with three double strokes (six single strokes), hence the unit annual energy consumption *AE* in kWh/year is
for mains operated vacuum cleaners:

AE = **17.4 x SE**

The Energy Efficiency Index (EEI) for the energy label would compare the measured AE with a standard energy consumption SAE of 43.5 kWh/year, with the formula

EEI= AE/SAE x 100.

which is calculated and rounded to the nearest integer.



Note that the rating no longer (also) depends on the cleaning performance. Instead, following the example of regulating dishwashers and washing machines, the ecodesign requirements for cleaning are set at a high level for all products. This significantly improves reproducibility and market surveillance effort, while it still guarantees a high energy efficiency combined with a good cleaning performance.

Table 2. Summary of parameters, standards and formulas for ecodesign and labelling of vacuum cleaners

symbol	description	unit	format	Standard (clause) or formula
hh, pro (suffix)	Sector end-use: household (*hh*), commercial (*pro*) or both (-)	*hh/pro*	-	declared
c, hf, gp (suffix)	Floor-type end-use: carpet only *c*, hard floor only *hf* or general-purpose *gp*	*c/hf/gp*	-	declared
main, bat (suffix)	Mains (*hh & pro*) or battery powered (*hh*)	*main, bat*	-	declared
AE	Annual energy consumption	kWh/a	x,x	$AE = \mathbf{17{,}4 \times SE}$
$P_{max,main}$	Maximum declared operating power $P_{max,main} \geq \max(P_c, P_{hf}, P_{gp})$	W	x	$P_c = 0{,}5\ P(deb_c) + 0{,}5\ P(dpu_c)$ $P_{hf} = 0{,}5\ P(deb_{hf}) + 0{,}5\ P(dpu_{hf})$ $P_{gp} = 0{,}25\ P_c + 0{,}75\ P_{hf}$
$P_{max,bat}$	Maximum declared operating power $P_{max,bat} \geq \max(P_c, P_{hf}, P_{gp})$	W	x	as above but with per cleaning test $P( ) = P_{aux} + P_{eff} + \mathbf{160} P_m$ *
S	Cleaning speed (*pro* & *c/hf/gp*) *hh:* denominators as shown *pro:* denominators 80%, 82%, 81% resp.	m^2/min	x,xx	$S_c = (v/60) \times B \times ⅓ \times (vac_c/80\%)$ $S_{hf} = (v/60) \times B \times ⅓ \times (vac_{hf}/90\%)$ $S_{gp} = (v/60) \times B \times ⅓ \times (vac_{gp}/87\%)$
SE	Specific energy consumption, single stroke	Wh/m^2	x,xx	$SE = P/(v \times B)$
dpu_c	Dust pick-up on carpet (*hh/pro* & *c/gp*)	%	x	EN 60312-1:2017 (5.3)
dpu_{hf}	Dust pick-up on hard floor (*hh/pro* & *hf/gp*)	%	x	EN 60312-1:2017 (5.3)
deb_c	Debris pick up on carpet (*hh/pro* & *c/gp*)	%	x	IEC 62885-2:2021 (5.5)
$deb_{hf,\ hh}$	Household debris pick up on hard floor (*hh* & *hf/gp*)	%	x	IEC 62885-2:2021 (5.3)
$deb_{hf,\ pro}$	Commercial debris pick up on hard floor (*pro* & *hf/gp*)	%	x	IEC 62885-8:2019 (5.101)
vac	Floor-specific soil removal (*pro* & *c/hf/gp*)	%	x	$vac_c = 0{,}5\ deb_c + 0{,}5\ dpu_c$ $vac_{hf} = 0{,}5\ deb_{hf} + 0{,}5\ dpu_{hf}$ $vac_{gp} = 0{,}25\ vac_c + 0{,}75\ vac_{hf}$
dre	Dust re-emission	%	x,xxx	EN 60312-1:2017 (5.11) or IEC 62885-2-2021
dB	Sound power level	dB(A)	x	IEC 60704-1 or IEC 60704-2-1 or IEC 60335-2-69
Q_N	Nominal battery capacity	Ah	x,xxx	Following manufacturer's instructions, also based on EN IEC 62133-2:2017 & IEC 61960-3:2017 for lithium ion secondary cells as well as EN IEC 62133-1:2017 and EN IEC 61951-2:2017 for NiMH secondary cells,
V	Nominal battery voltage	V	x,x	
RtE	Round-trip efficiency battery	%	x	
DoD	Depth of discharge (battery) at CycleLife test	%	x	
Cx	Rate of discharge (C-rate) at CycleLife test, *x* is QN multiplier	#	x	
CycleLife	Battery cycle life (till capacity fade 30%)	#cycles	x	
ET	Battery energy throughput	kWh	x	$ET = Q_N \times RtE \times DoD \times CycleLife$
P_{aux}	Auxiliary power of docking station when VC in use (not attached to docking station)	W	x,x	IEC 62885-4-2021 (*Pc1*)
P_{charge}	Charging power (battery)	W	x,x	IEC 62885-4-2021 (*Pc2*)
P_{eff}	Effective on-mode power	W	x,x	$P_{eff} = (T_{charge}/T_{operation}) \times P_{charge}$
P_m	Maintenance power: trickle charge, CPU off, standby and/or network power	W	x,xx	IEC 62885-4-2021 (*Pc3*)
T_{charge}	Charging time	h	x,xx	IEC 62885-4-2021 (16.6.1)
$T_{operation}$	Operation time (battery operated)	h	x,xx	IEC 62885-4-2021 (16.6.1)
$P_{off/sb}$	Off/standby mode P_m	W	x.xx	Comm reg 1275/2008/EC
$P_{sb,\ display}$	Standby & status display P_m	W	x.xx	Comm reg 1275/2008/EC

$P_{sb,\ network}$	Networked standby P_m	W	x.xx	Comm reg 1275/2008/EC
v	Stroke speed (default 1800 m/h)	m/h	x	EN 60312-1:2017
B	Nozzle width (0,2-0,5 m range)	m	x,xx	EN 60312-1:2017
F	Motion resistance	N	x	EN 60312-1:2017 (6.2)
muv	Maximum useful volume (receptacle)	Ltr.	x,x	declared by manufacturer
t_{motor}	Motor lifetime, empty or partially loaded	h	x	EN 60312-1:2017 (6.17)
t_{hose1}	Durability of primary hose (bending)	# cycles	x	EN 60312-1:2017 (6.9)
t_{hose2}	Durability of secondary hose (stretching)	# cycles	x	IEC 62885-2:2021 (6.9.2)
—	Disassembly aspects			EN 45553:2020
—	Recyclability & recoverability			EN 45555:2019
—	Critical Raw Materials (CRM)			EN 45558:2019
—	Material efficiency information			EN 45559:2020

*= 77 is 8026 h/(17,4×6)

Specifically for commercial VCs

While keeping one unique energy label, it is proposed to add specific elements suitable for commercial VC:

1) the cleaning speed S, in m2/min, is introduced as a parameter on the label. This is especially for commercial VC but also suitable for household VC in the interest of a level playing field;
2) there is a specific icon introduced per type: commercial VC use their debris (brass) and the household VC use their debris (nylon).

Furthermore, it is proposed not to penalize nozzle widths above 32 cm anymore, but allow nozzle widths up to 0.5m, e.g. for certain large unobstructed commercial surfaces (trade fairs, ballrooms, etc.).

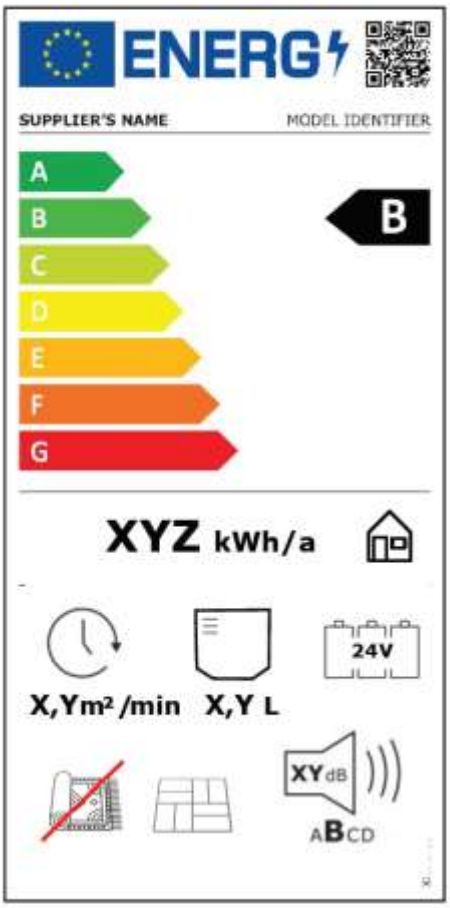
The following formulas apply.

S	Cleaning speed (hh/*pro* & *c/hf/gp*) *hh:* denominators as shown *pro:* denominators 80%, 82%, 81% resp.	m^2/min	x,xx	$S_c = (v/60) \times B \times ⅓ \times (vac_c /80\%)$ $S_{hf} = (v/60) \times B \times ⅓ \times (vac_{hf} /90\%)$ $S_{gp} = (v/60) \times B \times ⅓ \times (vac_{gp} /87\%)$
vac	Floor-specific soil removal (*pro* & *c/hf/gp*)	%	x	$vac_c = 0,5\ deb_c + 0,5\ dpu_c$ $vac_{hf} = 0,5\ deb_{hf} + 0,5\ dpu_{hf}$ $vac_{gp} = 0,25\ vac_c + 0,75\ vac_{hf}$

Circular Economy measures

As regards the circular economy requirements, the EC proposal from 2019 is fully taken on board with the stakeholder suggestions for expanding the spare part list.
Furthermore, vacuum cleaners are one of the home appliances using the most plastics and it can be investigated to set up information requirements –possibly supported by an icon on the label—for 3rd party certified post-consumer recycled content (%) for those VC manufacturers that make commercial claims on that issue. This still has to be discussed internally.

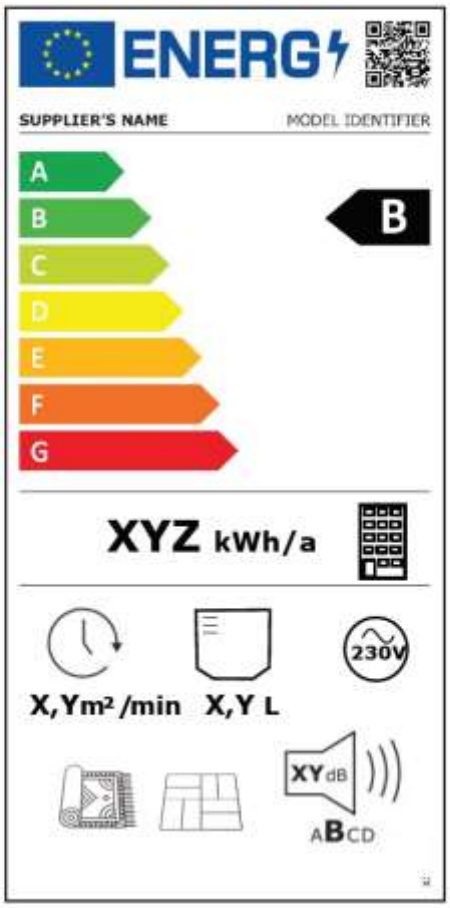
Energy Label



Example of the label for a

typical household vacuum cleaner

Energy class rating B
Annual energy use *AE* is XYZ kWh/a
Speed *S* is X.Y m²/min
Receptacle *muv* is X,Y L
Battery powered (24 V)
Hard floor only (not carpet)
Sound power XY dB (class B)



Example of the label for a

typical commercial vacuum cleaner

Energy class rating B
Annual energy use *AE* is XYZ kWh/a
Speed *S* is X.Y m²/min
Receptacle *muv* is X,Y L
Mains powered (230 V)
General purpose (carpet & hard floor)
Sound power XY dB (class B)

Energy Efficiency Class	Annual energy consumption (AE) [kWh/yr]	Energy Efficiency Index EEI
A (most efficient)	AE ≤ 10,0	AE ≤ 23
B	10,0 < AE ≤ 16,0	23 < AE ≤ 37
C	16,0 < AE ≤ 22,0	37 < AE ≤ 51
D	22,0 < AE ≤ 28,0	51 < AE ≤ 64
E	28,0 < AE ≤ 34,0	64 < AE ≤ 78
F	34,0 < AE ≤ 40,0	78 < AE ≤ 92
G (least efficient)	AE > 40,0	AE > 92

FOR DISCUSSION:

a. *The 2022 proposal set high minimum cleaning performances in ecodesign and focus the energy label on energy efficiency, in order to be coherent with other cleaning products such as washing machines and dishwashers. Do you agree with this approach?*
b. *In order to be as close as possible to real-life (and within the need to ensure reproducibility), the proposal is based on: 1) three double strokes; 2) partially filled receptacle; 3) universal nozzle; 4) not only dust but also debris pick-up (distinguishing household and commercial debris); and 5) a new cleaning speed criterion (relevant especially for commercial VC). Do you think this is enough to be as close as possible to real-life?*
c. *The 2022 proposal keeps both minimum debris and minimum dust pick-up on carpet as in the 2019 proposal. However, the debris dust pick-up is more reproducible than the dust pick-up carpet, while the industry seems to prefer the dust pick-up carpet. Is it fine to keep both as in the 2022 proposal or would there be negative effects to keep the dust pck-up in, due to its lower reproducibility?*
d. *Parameter S for general purposes gives 25% weight to carpet and 75% to hard floor cleaning performance to reflect real-life average use of the vacuum cleaner. Do you agree with this approach?*
e. *The information on Speed in m2/min was added primarily for the benefit of the commercial VC market, although it can be a relevant information also in a household context. Should it deserve more prominence on the label than what is proposed?*
f. *To avoid unrealistic practice of discharging the battery in a very short time just for the cleaning performance test, it is considered to require the battery capacity Q_N should last at least 20 minutes at Pmax (0,33hPmax) used for the cleaning performance tests. Do you agree with this approach?*

ANNEX I

Development of test standards: balancing reproducibility and real-life conditions

The standardisation working groups dealing with vacuum cleaner test standard EN 60312-1 [13] and the IEC 62885 series have been and still are working to bring test conditions as close as possible to real-life as the indispensable reproducibility criteria allow. Fair and reproducible measurement with a "partially loaded" receptacle requires determining the maximum useful volume (*muv*) of the 'fully loaded' receptacle with acceptable accuracy.

Even with precise instructions on how to load standard test dust (DMT8) and prepare the receptacles, large deviations in *muv* of the same bagged receptacle between laboratories were found (e.g. between 4.4 and 6.6 litres for one model). To determine "full" load the product's own indicator, if present, was used. Alternatively, the stopping point was set when the pressure dropped to a level below 40% of the initial value. Finally, the latest tests[14] were done with a load of 100 g/litre of manufacturer declared *muv*. To avoid circumvention, e.g. by declaring a smaller than realistic *muv* to optimise suction power, the *muv* would be clearly visible on the energy label as a commercial feature of the product.

As regards the number of double strokes in the cleaning performance tests, it was considered that –even with the current correction—a test with 5 double strokes was not realistic. Also the use of special nozzles, often optimised for the test at hand rather than real-life, was not considered realistic. It was investigated whether, accepting a larger uncertainty in reproducibility, it would be possible to use only 3 double strokes and a universal nozzle to establish the cleaning performance. As with the test of the *muv*, the reproducibility test with 3 double strokes and universal nozzle is now (February 2022) almost concluded.

So far, the test soil in vacuum cleaner tests was a standardised mineral dust (DMT 8) with acceptable reproducibility in dust pick-up. However, to test closer to real-life it was investigated the pick-up of larger 'debris' samples mimicking food spills of rice and lentils for households. For commercial vacuum cleaners more challenging heavy metal debris was considered. To be reproducible the debris had to be of a precise and constant size and weight. Therefore, not real rice grains or lentils were used but small (M3) nylon screws and nuts. For commercial debris brass nuts and washers were used.

The RRT of household debris pick-up[15] was tested with three different models/nozzles, showing that with a good passive nozzle and at 3 double strokes an average household debris pick-up could be realised for carpet of 88.5%, for resilient[16] floors 93.4% and for hard floors 89.1 %. The expanded uncertainty (meaning twice the standard deviation, extending beyond the min-max) was found to be in the range of 5-6%, which is satisfactory.

Finally, the Commission's Standardisation Request M/540 required addressing the use of market representative floors for vacuum cleaner testing. For this purpose, the vacuum cleaner working group CLC TC 59X WG6 established a liaison with CEN TC 134 on floor coverings to determine floorings that could be considered as market representative. As regards the testing of representative floor types, it was found that

- cut pile carpets are not suitable for lab testing (too delicate) ;

[13] CLC TC 59X WG 6

[14] Tests recently concluded, report expected in March 2022.

[15] Nylon nuts and washers in a random pattern (with minimum occupation per surface area). Note that commercial vacuum debris tests use brass nuts and washers in a strict geometric pattern.

[16] E.g. vinyl, linoleum, cork, polyurethane

- the tested loop pile carpets were no improvement compared to the existing loop pile carpets in the test standard;
- For resilient floor both the cushion vinyl (CV) and the Luxury Vinyl Tiles (LVT) were suitable;
- For hard floors both laminate and parquet are suitable.

The CV and laminate floorings were being tested in debris pick-up tests to gain experience in possibly using different floor types in the future, but for the moment it was found that the carpet and hard floor defined in the standard are a good choice for establishing market representative performance.