D2.2 - Topten ACT Criteria Paper

Vacuum cleaners

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Topten ACT aims at transforming the European market of energy-using products towards higher energy efficiency.

Topten ACT identifies the top energy-efficient products in 16 European countries, and makes this information available to consumers and large buyers on tailored national websites. The most energy efficient models in different product categories (such as household appliances, lighting, office equipment, consumer electronics, cars) are presented with comprehensive product information based on official labels and standardized declarations. Topten works with manufacturers and thus increases both market offer and consumer demand of high energy efficiency products. Topten is strictly neutral and independent from manufacturers and retailers, its selection criteria are always published online.

Topten ACT is supported by the European Commission's research and innovation programme Horizon 2020, and many national organisations (energy agencies, environmental and consumer organisations, research institutes). The Topten ACT project involves 17 partners in 16 European countries. It is coordinated by ADEME (Agence de l'Environnement et de la Maîtrise de l'Energie).

More information and access to all national websites on the European site: www.topten.eu

1. Topten.eu: vacuum cleaners current selection criteria and products selected

Topten presents upright and cylinder cleaners, with or without dustbag.

Topten.eu selection criteria in August 2018:

Energy efficiency	Class A+ or better
Cleaning performance on carpet / hard floor	Classes C/A, A/C or B/B (if one is A the other can be C, if the good class is B the other has to be B as well)
Dust re-emission	Class A

Vacuum cleaners currently on Topten.eu (last update: June 2018):

Cleaning performance class (carpet / hard floor)	Energy efficiency class	No. of products*
A / A	A+++	1
	A++	3
	A+	11
- / A	A++	2
B / A	A+	16
C / A	A+	18
Total		**51**

*Similar models have not been counted if from the same brand.

Topten models	1	3	2	4	24	5	8	1	2	1
Power	350W	450W	485W	500W	550W	600W	650W	700W	750W	800W

After the introduction of the new Lable with the "+" signs, A+, A++ and A+++ quickly emerged on the market.
There are 51 vacuum cleaner (VC) models on the Topten.eu product list, of 15 different brands: AEG, Bestron, Dirt Devil, Electrolux, Fakir, H.Koenig, Hoover, Kärcher, Miele, Nilfisk, Philips, Rowenta, Samsung, Severin Floorcare and Vorwerk. Almost as many products now reach the cleaning performance classes A (carpet) / A (hard floor) as B/A or C/A. Two products are for the use on hard floors only. The rated input power ('Wattage') ranges from 350W to 800W with a concentration at 550W; this is a marked improvement over the last 3 years where rated input power ranged mostly from 650W to 800W. Eleven of the Topten models are bagless.

Dyson is at the moment not present on the Topten.eu list, even though they have several low-power models. Their models however don't meet the cleaning performance criteria yet.

2. Expected selection criteria in 2019

The selection criteria for vacuum cleaners on topten.eu were tightened recently. Because of the advances in cleaning performance, we think that the tightening of selection criteria with regards to the cleaning performance classes to A/A for all types the most probable scenario for 2019.

3. Technical background
Vacuum cleaners (VC) can have two different shapes: either they have a canister / cylinder, to which the cleaning head is attached with a hose, or they are 'upright' with the dust bin directly attached to the cleaning head. Small, battery-operated VCs are called 'handhelds'.

They and compact battery-operated VCs are not covered by the VC Labelling and Ecodesign regulations and have no standardised energy declaration. They are therefore difficult for Topten to list and are not in the scope of this criteria paper.

Topten Switzerland has created a first list for battery-operated vacuum cleaners based on two tests, "Saldo Test" (Nr.4, 03.03.2010) and "ETM Test" (05.2011, 08.2014, 08.2017). The VCs were selected according to overall rating and battery running time. Currently 4 handheld and 11 upright battery-operated VCs from 4 brands are listed on topten.ch.

Figure 1: Canister, upright, handheld and battery-operated compact vacuum cleaners.

Vacuum cleaners can be bagged or bagless:
- bagged VCs: a vacuum bag is used to filter dirt out of a stream of air
- bagless VCs: a removable container and reusable filter is used to trap dirt

Consumers decide according to their personal preference: for bagless VCs there are no additional costs for bags, but the emptying of the canister can be a bit of a hassle and problematic from a hygienic point of view.

Bagless VCs however also have an energetic advantage over bagged VCs, which is not accounted for on the Energy Label: the cleaning performance of bagged VCs decreases quickly as the bag fills up with dust, while for bagless VCs the performance is not affected by the dust filling. All VCs are tested with a completely empty bag which is not representative of real-life conditions because the bag is never empty. Therefore, for bagged VCs the cleaning performance can be considerably lower in real-life conditions than what is declared on the Energy Label (or some models can go up with the power to compensate, so also the energy consumption can be higher than declared). For bagless VCs the declared values are closer to real life situation.

Dyson, who produces only bagless VCs, has been advocating for a change in the measurement standard to test VCs in a partly filled state instead of empty. Topten supports this change, as it would be closer to real usage conditions and overcome a systematic bias in favour of bagged VCs.

4. Policy measures, standards and labels

The EU Energy Labelling and Ecodesign regulations cover both household and commercial VCs, but not industrial, outdoor, central, wet, wet and dry, robot or battery-operated VCs. 'Hybrid' VCs that can be operated by electric mains or batteries are covered. Handhelds are not covered.

Expected savings from both regulations are 19 TWh per year (according to a 2013 presentation from Ismo Grönroos-Saikkala, former head of the EC's energy efficiency unit).
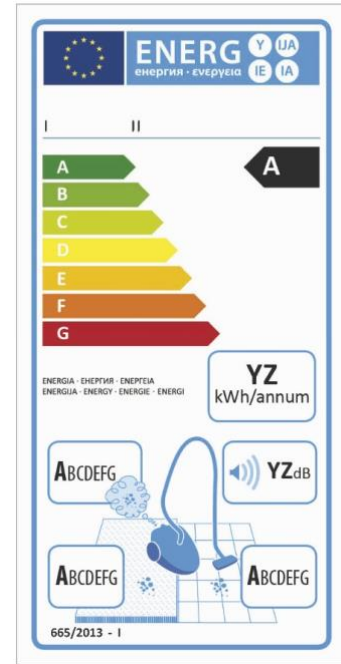
Energy Label

The Energy Label is based on regulation No. 665/2013 and is mandatory since 1st September 2014. The Label shows the following quality aspects:

- energy efficiency class: the classification is based on the annual energy consumption (kWh/year).
- annual energy consumption (kWh/year, calculation see below)
- cleaning performance classes on carpet and hard floor
- dust re-emission class
- sound power level

Additionally, the Label Fiche must inform about the rated input power (declared input power) of the VC model.

As you can see, each vacuum cleaner model is classified in four different aspects on the Label. Vacuum cleaners can also be declared as suitable for only cleaning either carpet or hard floors (but not both). This has to be indicated on the Label, and in this case only one cleaning performance class is declared. VC's suitable for cleaning both floor types (most models) are called 'general purpose VCs'.

Energy efficiency classes go from A to G. From 1st September 2017, energy classes will go from A+++ to D. Models that are better than class A can show this also before 2017.

Energy efficiency	Max. kWh/year	Comments
A+++	10	Shown on the Label for all models from 2017.
A++	16	
A+	22	
A	28	BAT 2015 (Topten)
B	34	
C	40	
D	46	Phase out 2017 (across class D)
E	52	
F	58	
G	> 58	

Table 1: Energy efficiency classes and corresponding maximum kWh/year

The annual energy consumption AE is calculated as follows:

$$AE = 4 \times 87 \times 50 \times 0.001 \times ASE \times \left(\frac{1 - 0.2}{dpu - 0.2}\right), where$$

- *ASE* is the specific energy consumption in Wh/m^2 that has been measured in the test
- *dpu* is the dust pickup that has been measured in the test

For general purpose VCs (suitable for cleaning carpet floor as well as hard floor) the average AE of AE$_{(carpet)}$ and AE$_{(hard floor)}$ is declared. The formula assumes that the VC is used 50 times per year, that 87m^2 are cleaned each time and that the VC is passed 4 times over each point (two double strokes).

The formula is not straightforward: it is not a real consumption formula, but the dpu (dust pickup, actually performance) in the denominator shows that it is actually an efficiency formula (or the inverse; inefficiency: consumption/performance) instead of a consumption formula (which is independent of performance). The formula assumes that a VC is used longer if its cleaning performance is lower, and therefore it will have a higher energy

consumption. It is however very unclear if people do really adjust their cleaning habits to the performance of the VC. The formula seems more complex than needed.

Cleaning performance class	Dust pickup on carpet	Dust pickup on hard floor	
A	> 91%	> 111%	
B	> 87%	> 108%	
C	> 83%	> 105%	
D	> 79%	> 102%	
E	> 75%	> 99%	
F	> 61%	> 96%	Banned after tier 2 (2017)
G	< 71%	< 96%	

Table 2: Cleaning performance classes for cleaning on carpet and hard floor

The dust pickup on carpet and hard floor respectively indicates the percentage of the test dust that could be sucked-in during the test. Dust pickup on hard floor can reach values > 100%. The reason is that 100% of the dust is considered to be what is on the exact area that is passed over with the cleaning head. Hard floor nozzles create a light vacuum on the floor and can also suck in dust that is not lying on the area that is passed over directly, but from the sides.

Dust re-emission class	Dust re-emission (%)	
A	0.02%	
B	0.08%	
C	0.2%	
D	0.35%	
E	0.6%	
F	1%	
G	> 1%	Banned after tier 2 (2017)

Table 3: Dust re-emission efficiency classes

The dust re-emission indicates how much of the dust that is sucked-in during the test left the VC again. Dust particles of a size between 0.3 and 10 µm are measured. Especially for allergic people a low dust re-emission is key.

Ecodesign requirements
The Ecodesign regulation for vacuum cleaners No. 666/2013 applies since September 2014.

	Tier 1 1 Sep 2014	Tier 2 1 Sep 2017
Max. annual energy consumption	62 kWh/year	43 kWh/year (in class D)
Max. Power	1600 W	900 W
Min. dust pickup on carpet	0.70 (in F)	0.75 (E)
Min. dust pickup on hard floor	0.95 (in F)	0.98 (almost class E)
Max. dust re-emission	-	1% (class F)
Max. sound power level	-	80 dB(A)
Durability	-	40'000 hose oscillations; 500 hours operational motor lifetime

Most requirements are not on the class thresholds but cut through classes.
One of the most effective (and at the same time simple) requirements from Topten's point of view is the power cap, which limits the rated input power to a maximum of 1600 W since 2014 and 900W in 2017.

Measurement standard

Declarations on the Energy Label are based on measurements according to EN 60312-1:2013 "Vacuum cleaners for household use – Part 1: Dry vacuum cleaners – Methods for measuring the performance".

The test is performed with empty bags or canisters. Reproducibility seems to be an issue in the dust pickup test, and aspects like the type of nozzle used can have a big impact on the result. An expensive, automatic laboratory is needed for the test (the VC needs to be passed over the test floor at totally constant speed). The stability of the VC is also tested, by bumping it into walls and over door thresholds.

Blauer Engel

There are 2015 award criteria by the Blue Angel for vacuum cleaners. Regarding energy, VCs must meet the following criteria: max. 900W, energy efficiency A, cleaning performance classes C/C and dust reemission class A. The sound power level (without active brush) must not be higher than 75 dB(A). Additionally, there are requirements regarding material, reparability and recyclability, durability and consumer information.

As of today, 2 models hold the Blue Angel label.

5. Market analysis

Market: transformation supported by the Energy Label

Before 2013 no policy measures or voluntary labels existed for vacuum cleaners. Communication towards consumers was driving them towards taking the Wattage declaration as a performance indicator, and high power was generally associated with good performance. Manufacturers were marketing VC's with higher and higher power declared ('1500W!', '1800W!', 2200W!'..). Instead of getting more efficient, VC's grew more energy-hungry. In the 2013 policy recommendations, Topten showed that VCs with higher power did not have a better dust pickup value.

The Energy Label now leads to a complete market transformation by presenting an incentive for energy efficient and low-Wattage vacuum cleaners for the first time, by showing information on cleaning performance and creating a benchmark for VCs with low energy consumption.

A presentation at EEDAL 2015 by GfK, a professional market research company, showed that

- Annual sales of cylinder vacuum cleaners are 17 million units. Sales numbers and value remained nearly stable with the introduction of the Energy Label (with a little decrease in units, but increase in value).
- Until 2013, 75% of the sold cylinder vacuum cleaners had a power > 1600W (50% 1800-2000W). In July 2014 – June 2015 this share shrank to 41%. VCs with power < 1200W had been nearly inexistent before 2014, now they accounted for nearly 35% of the sales.
- The share of low-Wattage sales keeps increasing: in June 2015 nearly 60% of the sold cylinders had a power < 1200W, 30% even < 800W.
- In July 2014 – June 2015 already 50% of the new cylinders (marketed after July 2014) reached energy efficiency class A, 36% reached hard floor cleaning performance class A (and 24% carpet cleaning performance class C, the best class with a considerable market share), and 30% dust re-emission class A.
- The average price increased to 117 EUR (from EUR 108 end of 2012) – it seems that the Label has added value; consumers are ready to pay a little more for high-quality products, which they are able to identify now.
- On the other hand, sales shares of VC types that are not covered by Ecodesign and the Label is increasing; especially handsticks, robots and handhelds (27% of total sales).

Conclusions are that the label and Ecodesign regulations for VCs have been a real success, benefitting consumers (ready to pay a little more for well declared and better products), industry (stable sales and increase in revenue) and the environment (lower energy consumption).

6. FAQ

Now that there is a power cap, are only low performance VCs left on the market?

Some media, especially in the UK and Germany, misused the Ecodesign regulation on vacuum cleaners for some 'anti-Brussels' News, saying that modern vacuum cleaners would no longer perform well because the power was going to be limited to 1600W and later even to 900W. But don't worry; there is no reason to fear that we'll all be coughing in dusty rooms:

- Good cleaning performance needs not high input power. With data from Topten we showed already in our August 2013 policy recommendations that models with power up to 1800W did not have a better dust pickup than a 1000W model (with two exceptions at 1200W and 1300W).
- Before September 2014, there was no incentive to make VC motors efficient. In other appliances we've seen efficiency improvement of around 50% being easily possible when there was an Energy Label, for VCs it should be the same. From this we can expect a good cleaning performance to be possible with around 500W or less, thanks to more efficient motors.
- Consumers can now choose VC models with good cleaning performance (on carpet and hard floor, A/A). Before 2014 consumers had no information about the cleaning performance of VC models.
- There is a minimum performance requirement in the Ecodesign regulation: low performance VCs can no longer enter the market.

What's better: bagged or bagless vacuum cleaners?

This is basically a decision according to personal preferences. The following pro and contra points can provide a basis for the choice:

Bagged	Bagless
+ Convenient changing of the dust filled bag	+ No costs for bags
	+ Performance and energy consumption remains the same with dust filling up
- Bags need to be replaced. According to Ecotopten.de yearly bag costs average at EUR 20.-.	- Hassle to empty the dust canister, dust can spill
- Performance can reduce and/or energy consumption go up quickly when bag the is filling up with dust.	

7. References and links

Useful links

Topten.eu vacuum cleaners product list and selection criteria:
www.topten.eu/english/household/vacuum_cleaners_list.html
www.topten.eu/english/criteria/vacuum_cleaners.html&fromid=

Information by the European Commission on the measures on Vacuum cleaners:
http://ec.europa.eu/energy/en/topics/energy-efficient-products-and-labels/vacuum-cleaners
There is also a consumer guide:
http://ec.europa.eu/energy/sites/ener/files/documents/Consumer%20guide%20-%20vacuum%20cleaners%20FIN.pdf
and an 'Energy Label generator': http://eepf-energylabelgenerator.eu/

References

AEA Energy & Environment: Work on Preparatory Studies for Eco-Design Requirements of EuPs (II) Lot 17 Vacuum Cleaners TREN/D3/390-2006; Final Report, February 2009

Energy Labelling regulation No 665/2013 for vacuum cleaners:
http://www.topten.eu/uploads/File/Vacuum_cleaners_Energy_Labelling_Regulation_2013.pdf

Ecodesign regulation No. 666/2013 for vacuum cleaners:
http://www.topten.eu/uploads/File/Vacuum_cleaners_Ecodesign_regulation_2013.pdf

Pierre Geismar, GfK: EU Energy Label on Vacuum cleaners: evaluation and market changes. Presented at EEDAL 2015, Lucerne.

Topten policy recommendations, August 2013:
http://www.topten.eu/uploads/File/Vacuum%20cleaners_Policy%20Recommendations_Aug_13.pdf

Ecotopten selection criteria:
www.ecotopten.de/sites/default/files/ecotopten_kriterien_staubsauger_0.pdf

Blauer Engel, vacuum cleaner criteria and models:
https://www.blauer-engel.de/en/products/home-living/vakuum-cleaners