Working document
highlighting options for a possible Commission Regulation implementing Ecodesign Directive 2009/125/EC and Energy Labelling Directive 2010/30/EU with regard to Vacuum Cleaners

1 Background

Since the 1960s input power ratings of vacuum cleaners has been increasing. The market trend shows an increase from a typical 500 watts in the 1960s to over 2500 watts today. While changes in measurement methods make direct comparisons difficult, there appears little evidence that this very large increase in energy consumption has been matched by a proportionate increase in cleaning performance.

Directive 2009/125/EC establishes a framework for the setting of Community ecodesign requirements for energy-related products with the aim of improving by product design their environmental performance throughout their life cycle and ensuring their free movement within the internal market. The directive provides for the setting of requirements which the energy-related products covered by implementing measures must fulfil in order to be placed on the market and/or put into service.

The recently adopted Directive 2010/30/EU which replaces Directive 1992/75/EEC provides for energy labelling of energy-related products, incl. household and non-household products. Appliances are rated in terms of energy efficiency classes which alongside other information shall be clearly displayed on the product's label when offered for sale or rent.

There is currently no EU legislation specifically dealing with the energy consumption of vacuum cleaners (VCs). A preparatory study on vacuum cleaners has been undertaken (lot 17).

2 Scope

A vacuum cleaner is an appliance that removes dry material (dust, fibre, threads) from the surface to be cleaned by an airflow created by a vacuum developed within the unit. The material thus removed is separated in the appliance and the cleaned suction air is returned.

The scope of the study included both domestic and commercial vacuum cleaners, and hand held battery appliances. Household VCs are primarily used in household or domestic situations whereas commercial VCs are intended for professional housekeeping purposes and for use by laymen, cleaning staff or contracting cleaners. These are used primarily in office, shop, hospitals and hotel environments for longer periods of time than a household vacuum cleaner. Normal maximum life expectancy is 500 hours for domestic VCs and 1500 hours for commercial VCs. The study showed that a consumer in a household will typically spend about one hour per week vacuuming. The study could however find no relationship between the time spent cleaning and the actual cleaning performance of vacuum cleaners.

The intended scope of implementing measures (ecodesign and labelling) would be all 'normal' vacuum cleaners intended for domestic cleaning or similar commercial cleaning (in shops, office, hotels etc.). As such, it would not include cleaners that required specially trained

operators. It is also proposed to include vacuum cleaners powered by batteries as far as the cleaners are intended for general use and are not hand-held.

Products excluded from the scope would be:

- Wet VCs, both 'workshop' vacuum cleaners that are designed to pick up water (or other liquids) and 'carpet cleaners' etc. that spray cleaning fluid on the surface and then vacuum it up. Vacuum cleaners that use water as a filter medium would be included (though lack of existing measurement methods may require a delay for these appliances)
- Industrial/commercial VCs for example used on construction sites or in factories. These are machines that are limited in use, possibly custom designed or used in hazardous or dangerous situations and require specially trained operators.
- Robot machines, meaning a cordless vacuum cleaner with “self drive”, using sensory feedback control to clean surfaces automatically. These VCs are a small market and are not directly comparable to domestic/commercial VCs in performance.
- Hand-held battery operated vacuum cleaners. These might be defined as those under a certain weight or with battery capacity below a limit.
- Sweepers (e.g. appliances that do not use a vacuum for dust pick up but use an electric motor driven brush roller to sweep surface dust into a collection tray). However, these alternatives to vacuum cleaners appear of interest – and so manufacturers of these should be encouraged to participate in the process.
- Central vacuum cleaners as these are only found in limited applications in Europe and do not correspond easily with general test procedures.

Option:

Require labels only on domestic vacuum cleaners (commercial vacuum cleaners would still need to provide the information e.g. in a fiche).

3 Environmental and health impacts

3.1 Table of environmental impacts

The table below shows the estimated environmental impacts for the EU stock 2005 as presented in the preparatory study.

Table 1: Environmental impacts EU-stock 2005

Main life cycle indicators	unit	Canister Domestic	Canister Commercial	Upright Domestic	Upright Commercial	Battery Cordless	TOTAL
Total Energy (GER)	PJ	315.92	21.28	55.30	3.73	7.52	**403.74**
of which, electricity	TWh	26.32	1.85	4.64	0.33	0.56	**33.69**
Water (process)*	mln.m3	28.88	2.03	5.08	0.36	0.76	**37.11**
Waste, non-haz./ landfill*	kton	803.35	64.69	118.94	6.30	23.06	**1016.33**
Waste, hazardous/ incinerated*	kton	71.80	2.96	11.91	0.51	2.92	**90.10**
Emissions (Air)							
Greenhouse Gases in GWP100	mt CO2eq.	14.28	0.95	2.50	0.17	0.35	**18.25**
Acidifying agents (AP)	kt SO2eq.	82.39	5.75	14.19	0.95	1.85	**105.13**
Volatile Org. Compounds (VOC)	kt	0.23	0.01	0.04	0.00	0.01	**0.30**
Persistent Org. Pollutants (POP)	g i-Teq.	3.39	0.22	0.62	0.04	0.27	**4.54**
Heavy Metals (HM)	ton Ni eq.	11.07	0.59	1.91	0.09	0.39	**14.06**
PAHs	ton Ni eq.	2.34	0.12	0.37	0.02	0.07	**2.92**
Particulate Matter (PM, dust)	kt	30.18	1.21	5.39	0.21	1.23	**38.22**
Emissions (Water)							
Heavy Metals (HM)	ton Hg/20	4.96	0.33	0.82	0.04	0.16	**6.31**
Eutrophication (EP)	kt PO4	0.35	0.02	0.06	0.00	0.01	**0.44**

*=caution: low accuracy for production phase

The study distinguished between 5 base cases: domestic and commercial canister and upright vacuum cleaners and small battery operated models. The main difference between canister and upright models is that the latter typically have brushes/agitators. The main difference between domestic and commercial appliances is that the latter are more robust with longer lifetimes (1500 hours rather than 500 hours).

The calculations for total environmental impacts assumed a total stock of 342 mill. vacuum cleaners and an annual sales volume of 46 mill. vacuum cleaners in 2005. The share of canister and upright VCs was assumed to be 85/15, both for the domestic and the commercial sector. The calculations above were furthermore based on the following assumptions:

Table 2 Use phase inputs by base case

	Domestic Canister	Commercial Canister	Domestic Upright	Commercial Upright	Battery / Cordless
Lifetime (years)	8	8	8	8	5
Electricity consumption per hour (kWh)	1.5	1.1	1.5	1.1	0.024
No. of hours per year in use	62.5	187.5	62.5	187.5	832
Standby electricity consumption per hour (kWh)	0	0	0	0	0.00082
No. of hours per year at standby	0	0	0	0	7891

3.2 Noise

Noise is an environmental pollutant and the control of noise levels of vacuum cleaners should not be ignored. The eco-label criteria for vacuum cleaners which is now expired included criteria for noise, <76 dBA. Vacuum cleaners exhibiting this performance can be considered as best performing in this respect.

Noise levels are measured as Sound Power (LwA) and presented in Decibels (dBA). Sound Power is an absolute measurement of noise level and is what is generated by the vacuum cleaner. It is independent of environment and gives a more accurate representation of the power of a vacuum cleaner to produce noise. As the decibel scale is logarithmic, an increase of 3dB means that the sound power is doubled. However a difference of 3dB is the smallest difference that is normally audible to the human ear.

Given that noise from vacuum cleaners is a significant impact, it may make sense to supplement the dB figure included in the white goods labels currently being adopted with some clearer consumer indication such as an A-G scale.

Option:

- *Include an A-G scale for noise on the label (e.g. ABC**D**EFG).*
- *Set Ecodesign requirement, for example the 76dB limit used for the Ecolabel*

3.3 Dust re-emission / filtration performance

In order to prevent dust and dirt from re-entering the atmosphere vacuum cleaners require filtration.

The revised measurement standard will include a method of measuring the re-emission of the small particles (0.2-4 micron) that are considered to be the most damaging to human health. Good quality vacuum cleaners can remove over perhaps 98 % of such particulates that are sucked up by a vacuum cleaner. As such they can help to lower the level of such particulates in indoor air, where they are typically several times higher than in outdoor air and as a consequence help to significantly reduce human exposure. However, given that there are already substantial quantities of such particulates in outdoor air, it seems unlikely that improvements over levels of say 98 % will have any significant effect on indoor air quality. Nonetheless this is an important performance criterion, in particular for those household members suffering from asthma or other lung conditions.

Filters vary enormously in efficiency and effectiveness and there are standard test methods to determine how effective a vacuum cleaner is at retaining its dirt and dust once it has been picked up. Usually the more effective a filter is at stopping and trapping the dirt the more energy it absorbs from the airflow. This can negatively affect the cleaning performance.

Option:

- *Either Ecodesign requirement only (e.g. 98% of 0.2 – 4 micron particles removed)*
- *Ecodesign requirement plus A-G scale on labels (e.g. ABC**D**EFG).*

3.4 Cleaning performance / dust removal efficiency

Increased dust removal ability implies increased indoor hygiene of households, but information that exists for consumers in terms of cleaning performance is often confusing and sometimes misleading.
Dust removal can be defined as the capacity of removing dust from specific surfaces during a specified number of cleaning cycles. Historically cleaning performance has been measured at 5 double strokes. This is more intense cleaning than normal use. It would also be possible to measure this after a more realistic 2 double strokes. However, there is little evidence that this would change the ranking of machines.

Option:

- Assess cleaning performance (both on carpets and hard floors) after 2 double strokes rather than the current 5.

3.5 Energy consumption

In 2005, the use phase electricity consumption for VCs was estimated to be around 30-35 TWh, 90 % from the domestic sector. This represented over 90% of the cradle to grave energy use.

The study found that in respect of domestic canister vacuum cleaners (which represent the large majority of the market) using a passive nozzle, that around 250 watts of 'suction power' at the nozzle was required to achieve a good level of dust pick up (i.e. the power represented by the air flow through the nozzle). This was the level of normally used by such vacuum cleaners until around 1980.

The input power of the vacuum cleaner will need to be higher due to losses from:

- Conversion of electricity into air flow by the motor and fan combination
- Power losses in filtration to separate the dirt from the air flow
- Leakages in the system
- Airway losses due to friction etc in the hoses pipe work etc

The study found that raising the efficiency of the fan to around 50% would be cost effective.

Reducing the other losses was very cost effective with additional costs (in a newly designed cleaner) being very low (less than €1 at consumer price).

In addition there was a potential saving as lower power requirement meant a lower power motor which would cost less (at the same efficiency level).

The power requirements of an optimized canister vacuum cleaner would be around:

Table 3 Power requirements of an optimized canister vacuum cleaner (from study)

	Power W
Suction power requirement at nozzle	270
Airway	40
Leaks	15
Filtration	35/50
Air power required from fan	375
Conversion efficiency (fan /motor)	50%
Average power requirement Vacuum cleaner	750 W (electric)

Active Nozzle - Powered brush/agitator

By vibrating the surface being cleaned, a powered brush or agitator improves the release of dirt that was attached to the surface to be cleaned. This is particularly true for carpets, where it helps to release deeply embedded dirt.
The study also found that using a motorized brush meant a much lower suction power requirement, on an equivalent basis this would lead to an overall average power requirement (electric input) of as low as 400 W. However, the introduction of energy efficiency requirement that implied the need for agitators or motorized brushes raises a number of issues:

- Cost

The reduction in energy consumption (power down from 750W to 400W) would imply a lifetime (500hours of use) saving of around €26. There has been some discussion as to how much such a motorized head would cost, with the industry suggesting it would be higher than this. Clearly the use of motorized brushes would be more cost effective on commercial machines with a longer lifetime (1500hours of use).

- Damage

Concern has been raised that motorized brushes might cause damage, particularly to valuable/delicate carpets. Careful design may be able to avoid this question, but at present we have little or no information on this aspect.

- Effectiveness on hard floors

At present there is little consensus as to how much the use of a motorized brush or agitator helps the cleaning process on hard floors, and so whether a lower power (say 400W) vacuum cleaner would clean well on hard surfaces.

- Active nozzle - High tech nozzle

The study suggested that there was a possibility that by redesigning the nozzle it would be possible to achieve many of the benefits of brushes by a redesigned nozzle that would agitate the surface being cleaned. While there appears to be good reason to hope that this will be achievable, there is no clear example of such nozzles on the market, so this must be considered 'not available' technology (BNAT). However, a labelling scheme could take into account this possibility.

Measuring energy consumption

In actual use the energy consumption of a vacuum cleaner is effectively the product of the average electric power input[1] and hours of use. So far there are two ideas for defining 'standard power consumption' for vacuum cleaners.

The study suggested that in practice the performance of vacuum cleaners did not affect how long people cleaned, so that input power was a good measure of energy consumption. The draft measurement standard defines how to measure the power consumption to reach a specified level of cleanliness.

We have not been able to find much in the way of evidence how performance affects hours of use. However, it may be reasonable to assume that most people will only extend their cleaning time if the surface cleaned still 'looks dirty' (there is visible dirt). If a 'couple of strokes' leave visible dirt they may carry on cleaning until the surface looks clean (but they will also probably be dissatisfied with the vacuum cleaner).

Assuming an energy label includes an A-G scale 'energy consumption' and 'cleaning performance' and possibly 'dust re-emission'. It seems likely (on the basis of experience from washing machines and dishwashers) that the public will first go for a good level (A) of cleaning performance, then for a good level of energy consumption, then for a lower noise level (dust re-emission will probably come last except for those with asthma etc.).

If the energy consumption is based on the consumption to reach a given level of cleanliness we will benefit high power high performance machines (which will in reality consume more energy). The risk is the label will promote high cleaning performance, but will do little to decrease energy consumption.

4 Measurement Method

Performance standards for vacuum cleaners go back many years. The current standards are EN/IEC 60312. The Commission issued a mandate to Cenelec in 2004, which inter alia asked for the development of methods for measuring the re emission of small (0.2- 4 micron) particles. In accordance with their contract, Cenelec should adopt the revised standard later this year. The relevant PrEN should be available shortly.

The existing method measures energy consumption and cleaning performance (dirt pick up) and data is comparable with those that will be obtained under the revised measurement standard.

The test method describes how to measure the energy consumption and cleaning performance after 1, 2, 3, 5, 7 and 10 double strokes. However historical data is mainly related to 5 double strokes.

[1] This power consumption (measured during testing is typically a little lower than the nominal declared power (as on the rating plate)

4.1 Issues relating to measurement method.

Cleaners with water filters

The current measurement method does not cover vacuum cleaners using water filters. Such methods could be developed, but this will take time.

Cleaning performance

Traditionally cleaning performance has been measured after 5 double strokes. This is clearly far more cleaning than is done in reality which is probably around 2/3 double strokes. It would be desirable to change to performance levels based on a lower number of double strokes (probably 2). However, given the lack of historical data it would be more difficult to set thresholds for Ecodesign requirements or labelling (A to G scale for cleaning performance).

Annex

The basic structure for ecodesign and energy labelling measures could be as follows:

Table 5 Possible energy label and ecodesign requirements for vacuum cleaners

	Energy Label	Ecodesign Requirement
Energy consumption	A-G colored scale	✓
Cleaning Performance (for carpets and hard floor separately)	A-G (letters scale)	✓ (at low level, such as 65% carpets, and 95% hard floor after 5 double strokes)
Noise	Possible A-G (letters scale)	Possible limit for example at 76dB re 1pw as set in Ecolabel
Dust re-emission	Possible A-G (letters scale)	Fairly strict requirement (e.g. better than 98%)

Categories

Defining separate categories for type of vacuum cleaner (canister or upright) would be difficult and it is not clear that it would be useful as there are probably an increasing number of appliances that could be described as either of these.

For commercial and domestic VCs, it is possible that a longer lifetime for commercial might justify stricter requirements. However, making defining a technical difference would be difficult, while commercial operators could always buy domestic appliances, so making a differentiation is unlikely to be helpful.

Battery operated models.

The study suggests that larger battery operated models that are intended to replace mains operated machines may come on the market in the near future, in this context it would appear sensible to include them in any measure. Small hand held appliance would not be covered in this measure.

Table 6 Possible list of labelling information to be provided

	Label	**Fiche**	**Distance selling**
Energy efficiency class	A-G	A-G	A-G
Cleaning Performance (dust removal)			
Carpet	A-G,	A-G, %	A-G, %
Hard Floor	A-G	A-G, %	A-G, %
Fractional filtration efficiency	A-G	A-G, %	A-G, %
Nominal input power		W	W
Average Annual Energy Consumption (AE_C)	kWh	kWh	kWh
Noise	A-G	A-G, dB	A-G, dB