AEA Energy & Environment
From the AEA group

Work on Preparatory Studies for Eco-Design Requirements of EuPs (II)

Lot 17 Vacuum Cleaners

TREN/D3/390-2006

Interim Report

Report to European Commission

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Intertek ETL SEMKO

ConsumerResearchAssociates LTD

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1 Task 1 Definition

1.1 Product Definitions

Product definition is an important issue because it helps set the scope of work for this preparatory study, which itself will inform the extent of EuP implementing measures that may be required.

Vacuum cleaners (VCs) are made in a variety of shapes and sizes for domestic and commercial use and for different applications. Generally, a vacuum cleaner can be defined as: "An electrically operated appliance that removes soiled material (dust, fibre, threads) from the surface to be cleaned by an airflow created by a vacuum developed within the unit by an electrically powered vacuum generator or fan. The material thus removed is separated and stored in the appliance and the cleaned suction air is returned to the ambient." The project team understands that IEC are considering a definition along these lines for the next edition of standard IEC 60312.

1.1.1 VC type Descriptions

The following list gives the most common types of vacuum cleaner put on the market.

(These first two definitions are purely technical)
Clean Air type (also known as indirect air)
A type of vacuum cleaner where the dirty air is pulled into a receptacle by the suction airflow ensuring that the airflow which subsequently passes through the vacuum generator (fan) is cleaned and filtered. This same airflow is used to keep the electric motor cooled.

Dirty Air type (also known as direct air)
A type of vacuum cleaner where the dirty air is pulled through the vacuum generator (fan) directly before being "blown" into the dirt storage facility. The electric motor has a separate cooling facility in this case. Historically this type of system has only been used for dry upright vacuum cleaners. They tend to require less energy for the cleaning process.

Upright Cleaner
A vacuum cleaner with the cleaning head forming an integral part of or permanently connected to the cleaner housing, the cleaning head normally being provided with an agitation device to assist dirt removal and the complete cleaner being moved over the surface to be cleaned by means of an integral handle. It is suited to cleaning carpet and floor areas.

Canister/ Cylinder/Suction Cleaner
A vacuum cleaner with the cleaning head separated from the vacuum generator (fan) and soil storage facility, usually by means of a flexible hose. The dirt is normally removed using suction power only. This type of cleaner is better suited to cleaning above floor level, e.g. upholstery, stairs etc., but is also used for cleaning carpets and floors however.

Stick Cleaner
A lighter weight vacuum cleaner with dirt storage facility and vacuum generator (fan) mounted centrally on a handle and integrated with a rigid connection to the cleaning head. The dirt is normally removed using suction power only.

Handheld
A lightweight vacuum cleaner with cleaning head, dirt storage and vacuum generator integrated in a compact housing allowing the cleaner to held and operated whilst being held in the hand. It may or may not have an agitation device incorporated.

Combination
A. With the addition of a powered nozzle (may be electric, air or mechanically driven agitation device incorporated into a separate cleaning head) a canister or stick cleaner can have an equivalent cleaning action to that of an upright.

B. An upright may be fitted with an integral housing allowing use of a separate cleaning head which may use suction power alone or a powered agitation device to remove dirt from surfaces in the same manner as a canister cleaner.

Extractor
An "Upright" vacuum cleaner with means of storing and dispensing water based cleaning solution on to the surface being cleaned and removing the dirty liquid into a second storage facility. Used to "wash" carpets and hard floors

3 in 1
A "canister" vacuum cleaner with means of storing and dispensing water based cleaning solution through a flexible hose to a separate cleaning head. With a second storage facility for storing the removed dirty liquid. Also used for "washing" carpets and hard floors.

Wet/Dry
A "canister" vacuum cleaner with a single tank for storing dirty water which has previously and separately been placed on the surface being cleaned or dried through a flexible hose and the separate cleaning head. Often used in garages and home workshops.

Other definitions relate to the function or applications of the vacuum cleaner:

Mains Powered
A vacuum cleaner connected to a mains voltage electrical supply during its operation.

Cordless
A vacuum cleaner with integrated electrical supply (usually low voltage DC) using rechargeable battery storage of electricity for operational use. It is only connected to the mains electrical supply for the purpose of recharging the batteries.

Robot
A cordless vacuum cleaner with "self drive", using sensory feedback control to clean surfaces automatically.

Bagless
A vacuum cleaner which employs a reusable container, usually rigid in form, and separate filters to remove and store the soil from the airflow. Dirt container is reusable thus saving the usage of bags.

Bagged
A type of vacuum cleaner which uses a disposable dirt storage container. Once filled it is (disposed of and a clean container is fitted in its place..

Household
A vacuum cleaner which is used primarily in household or domestic situations.
(Normal maximum life expectancy – 500 hours actual use)

Commercial
A vacuum cleaner intended for professional housekeeping purposes and for use by laymen, cleaning staff or contracting cleaners, which is used primarily in office, shop, hospitals and hotel environments for longer periods of time than a household vacuum cleaner.
(Normal maximum life expectancy – 1500 hours actual use)

1.1.2 Types of Filtration

Vacuum cleaners filter the dust and dirt from the airflow after picking up from the surface being cleaned. This prevents any dirt being blown back into the atmosphere after cleaning. There are various types of filtration used and these are defined here.

1.1.1.1 Barrier Filters.

Cloth.

The earliest vacuum cleaners used woven cloth bags to “capture” the dirt. They were usually quite large to increase the filter area and it was generally recommended to empty them weekly. Some vacuum cleaners still used reusable cloth filter bags.

Paper.

Paper bags started appearing in the 1930s and were designed to be used once only so the dirt was thrown away with the bag. Paper bags have been used as reusable with the danger of breakage being increased every time used! Some bags use multiple layers of paper to improve the ability to trap more dust without losing suction power.

Paper is also used as a medium for basic fixed filters (i.e. used in addition to a bag or receptacle), these would need to be replaced regularly as they filled with dirt. Heavier, impregnated papers, usually formed in a concertina fashion (to increase filter area) are designed to be cleaned and reused.

Artificial Fibres.

Materials such as polypropylene are used as fibres to form filters, they may be rigidised or left “soft”. Man made fibres form the basis of a material commonly known as “fleece”. This is generally heavier and provides bulk to hold large quantities of dust before “clogging”. When used as a bag material this generally produces very low loss of suction as it fills.

Liquid.

Water is normally used as the filter medium, the air is forced through the water entrapping the dust as it passes through. The dirty water is then thrown away at the end of the cleaning process.

An alternative use of water is simply to inject a fine stream into the dirty airflow to entrap the dust and dirt which is then collected in a receptacle to be thrown away as before.

Solid.

Sintered plastic materials are sometimes used to form a moulded rigid dirt receptacle. The sintering process causes the walls of the receptacle to be porous so that they act as a filter.

1.1.1.2 Non Barrier Filters.

Cyclones.

A cyclonic filter is usually cone shaped and directs the air in a centrifugal manner with sufficient velocity to “throw” heavier than air particles out of the airflow to be trapped in a fixed receptacle. Single cyclones are good over a specific range of particle sizes and weight. Usually they are not sufficient to filter out the whole range of particle sizes encountered by a vacuum cleaner. The Dual Cyclone uses two different sized conical cyclones in series to increase the range of particle sizes filtered. Multi cyclones usually have a single first stage and multiple second stage cyclones in parallel. Cyclones are excellent for filtering dust type solids but can have some problems with fibrous materials due to a tendency to agglomerate as they enter the cyclone. This may be dealt with by use of a coarse filter or barrier prior to that occurring.

Electrostatic.

Not commonly found, but they use an electrostatic charge to attract dust from the airflow.

N.B. some barrier filters have an electrostatic charge applied.

1.1.1.3 Combination Filters.

These are usually cyclones (first) and barrier filters used subsequently in series. Single cyclones will need good barrier filtration to trap other particles not affected by the cyclone. Even second stage multi cyclones may require additional barrier filtration as they can allow certain amounts of dust to pass through.

1.1.3 Product Classifications

PRODCOM[1] classifies vacuum cleaners in the NACE[2] 29.71 (Manufacture of electric domestic appliances). PRODCOM 2006 lists:

29712113 (Domestic vacuum cleaners with self-contained electric motor for a voltage >= 110V), and
29712115 (Domestic vacuum cleaners with self-contained electric motor for a voltage < 110V)

PRODCOM 2007 (introduced 11th December 2006) lists:

29712123 (Vacuum cleaners with a self-contained motor of a power <= 1500 watt and having a dust bag or receptacle <=20 litres)
29712125 (Other vacuum cleaners)
29713010 Parts for vacuum cleaners

1.2 Scope of the study

Key aspects in the considerations of the scope of this study are

- Functionality – the function of a vacuum cleaner is to "remove soiled material (dust, fibre, threads) from a surface to be cleaned by an airflow created by a vacuum developed within the unit by an electrically powered vacuum generator or fan".
- End use (domestic / commercial) – this study focuses on products designed for domestic/household use and similar usage by laymen in a commercial or institutional environment such as shops, hospitals, offices, and hotels, for removal of settled dust on carpets and dry hard floors. Because of their specialist application, it is not sensible to include industrial vacuum cleaners used, for example, on construction sites or in factories.
- Availability of test standards – For example, the definition according to Standard 60335 is: "This International Standard deals with the safety of electrical appliances for households and similar purposes, their rated voltage being not more than 250 V for single-phase appliances and 480 V for other appliances. Appliances not intended for normal household use but which nevertheless may be a source of danger to the public, such as appliances intended to be used by laymen in shops, in light industry and on farms, are within the scope of this standard. Note 1: Examples of such appliances are catering equipment, cleaning appliances for industrial and commercial use, and appliance for hairdressers. Note 3: This standard does not apply to: appliances intended exclusively for industrial purposes;…."
- Complementary to other EU initiatives (e.g. the EU Energy-Label covers cylinders and uprights but not central VCs and cordless/battery VCs as they consume small amounts of energy or are only found in a few locations).
- Energy required for the function. What is the optimum energy required for good cleaning?

1.2.1.1 Products excluded from scope

- Central vacuum cleaners as these are only found in limited applications in Europe.
- Wet and dry vacuum cleaners.
- Industrial / commercial VCs designed for specialist applications as these are limited in use, possibly custom designed or used in hazardous or dangerous situations.
- 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)[3].

[1] PRODCOM classification: List of PRODucts of the European COMmunity.
[2] NACE -- Classification of Economic Activities in the European Community
[3] However, these alternatives to vacuum cleaners appear of interest – and so manufacturers of these should be encouraged to participate in the process.

1.2.1.2 Products to be considered in scope

Household and similar use vacuum cleaners of all types found in homes, offices, hospitals, hotels, and shops.

1.3 Test Standards and Product Testing Procedures

1.3.1 Europe

There are two major standards applicable to vacuum cleaners in Europe and these are EN 60335.2.2 and EN 60312. Both are harmonised with the equivalent IEC standards in accordance with the Dresden Agreement, although there are some small common European amendments for EN 60335.2.2. Each European country adopts them as their own National Standards (e.g. BS EN 60312).

EN 60 335 is relevant to safety and also gives the method by which input power is defined. Nominal input power is the arithmetic average of maximum input power (watts) and minimum input power (watts). Maximum input power is measured when the airflow is at the highest, sometimes called "open airflow". Minimum Airflow is measured when airflow is zero, sometimes called sealed suction. The rating label of the vacuum cleaner will display the nominal input watts and allows for a tolerance of 10 percent. Some manufacturers use the tolerance and refer to this as "IEC" input watts and also add "maximum" input watts with a 10% tolerance. This device allows manufacturers to claim the "highest" input power figures and some do this to gain benefit in the market place where consumers generally associate high power with good cleaning efficiency (see below).

EN 60312 is relevant to performance and contains many test methods to measure performance relative to cleaning on different surfaces and with different types of soiling (see Box 1).

1.3.2 Box 1

Performance test measurements for vacuum cleaners included in the 60312 standards.

1. Dust removal from hard flat floors
2. Dust removal from hard floors with crevices
3. Dust removal from carpets (measured using a wool Wilton carpet)
4. Edge cleaning effectiveness
5. Fibre removal effectiveness from carpets and cushions
6. Thread removal from carpets effectiveness
7. Maximum volume of dirt receptacle
8. Airflow performance data
9. Performance with a loaded receptacle
10. Dust emission
11. Manipulative effort
12. Durability Tests
13. Life Test
14. Energy consumption

EN 60312 also contains test methods for indicating product life and also air flow characteristics. The major airflow characteristic is known as Suction Power or Airwatts and this occurs as a combination of both suction and airflow; it is evaluated by measuring the airflow in litres per second and multiplying that by the measured suction at that airflow and by a "constant" which gives the suction power. It usually peaks somewhere between sealed suction and open airflow. The maximum suction power divided by the input power at the same point determines the maximum airflow efficiency of the vacuum cleaner. This value, which is not related to cleaning efficiency, is normally quite low, rarely above 50% and is often around 35%. So input power is, in many cases, converted mostly to heat and some 2000+ watt vacuum cleaners are more or less 1200 watt fan heaters! This is typical for all types of vacuum cleaners as it is a consequence of inefficiencies in the vacuum generating fan where high airflows are moved through tight turns and restrictions whilst passing through the fan chamber. The motor alone is much more efficient, usually above 90%, as it converts electrical power into rotational mechanical power.

This study should examine this in more detail as it has become common practice for vacuum cleaners to require very high inputs, up to 2700 watts to date, and yet they are alleged to not clean any better than vacuum cleaners with lower input power requirements. It is also important to highlight that neither input power nor airflow efficiency necessarily have any correlation with cleaning performance.(See Box 2)

1.3.3 Box 2

Cleaning Performance Parameters.

There are test methods to measure the cleaning performance of vacuum cleaners, however the following gives a guide to actual requirements to produce good cleaning performance.

1. Input Power.
It is the project team's experience that there is no correlation between input power and cleaning performance other than the fact that there is a lower limit below which no cleaning performance would occur at all and then a small band of rapid improvement followed by a wider band of small or negligible improvement and finally no discernable improvement can be seen. These values will differ between upright and cylinder cleaners, i.e. those cleaners which use agitation to remove dirt and those which use suction power alone.
To give a guide to the level of these values it should be noted that a typical Hoover Junior upright vacuum cleaner as sold in the 1960s, with 250 watts input would clean a carpet as effectively as many of vacuum cleaners on sale today, including those with 2700 watts input. A cylinder cleaner may typically require 1000 watts input to match an upright if suction power alone is to be used, however with a power brush this could be reduced significantly, even accounting for the additional power required by the brush. The team aims to prove this assertion by subjecting a cordless 250 watt vacuum cleaner to "on carpet" and hard floor with crevice testing.

2. Suction Power.
There is a little more correlation between suction power and cleaning performance, particularly when comparing cylinder cleaners only using suction power for cleaning. However the design of the actual nozzle is more important.

3. Airflow.
Airflow is a key element in carrying removed soil away from the cleaning head, into the dirt receptacle. Below a certain level the airflow will simply not be sufficient to transport the dirt, this value is normally around 18 ft3 per minute (8.5dm3 per sec).

4. Agitation (brushing).
Agitator or brush design has more effect on carpet cleaning performance than any other factor. Typically there is an optimum speed of rotation for an agitator (usually around 3000rpm). The bristle rigidity and length is also important. Modern upright vacuum cleaners tend to have more aggressive brushing than those sold 20 years ago and this may lead to some form of carpet wear in some cases. It should be noted that whilst an agitator is good at removing soil from surfaces, the vacuum cleaner must provide sufficient airflow in order to carry the removed soil to the receptacle.

5. Dirt Receptacle and Filtration.
Dirt receptacles may either be filters in their own right or may be rigid containers which require separate filtration. Some disposable dirt receptacles have a form of auto sealing when removed from the vacuum cleaner which may improve the situation regarding the hygienic disposal of dirt.

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 picked up. Usually the more effective a filter is at stopping and trapping the dirt the more energy it absorbs from the airflow and this can affect the cleaning performance. Barrier filter efficiency can be measured in accordance with a European Standard (EN 1822) which is used to measure the efficiency of retaining the most penetrative particle size. The more effective filter media are defined as HEPA (High Efficiency Particulate Airflow), there are grades of HEPA, the highest being HEPA 13. Even more efficient filters are known as ULPA (Ultra Low Particulate Airflow). However even a high quality filter media loses its effectiveness if it is not fitted well into the vacuum cleaner. Generally, the thicker the filter barrier the more capacity it has to retain dirt before affecting airflow. However the distance the air has to pass through the barrier will, in itself, reduce airflow, So there is a balance to be sought when designing the most efficient filters. The most effective way to reduce airflow loss is simply to increase the overall area of the filter. The original cloth bags had such a large filter area that despite their relatively low filtering ability were still able to trap dust and dirt effectively because the velocity of airflow through

was also low hence the energy of particles was also low, making them easier to stop.
Cyclones also absorb energy, in order to create the centrifugal velocities and forces. Multiple Cyclones in series can absorb as much energy as a clean heavy duty barrier filter. The use of multiple second stage cyclones in parallel has led to a reduction in energy absorbed but may allow more dust to pass through thus requiring the subsequent use of barrier filters in addition to the cyclones.
Dust emissions from vacuum cleaners are measured in accordance with a method specified in EN 60312 4th Edition, Clause 2.10. In addition an ASTM test method, F1977 can be used to measure the overall fractional filtration efficiency of a vacuum cleaner and a new ASTM standard, F2308 can be used to measure the overall emissions of a vacuum cleaner while in use. These standards are methods of measurement and do not specify “pass” or “fail” criteria.

EN 60 312 also refers to IEC 60704 which measures noise level of vacuum cleaners.
When making performance claims in the UK the ASA code of practice determines that manufacturers use IEC 60312 for performance measurement methods, but this is not extended through the rest of Europe. However it is normal for 60312 to be used.

Noise levels for vacuum cleaners are measured using EN60704-1-2. Noise levels are measured as Sound Power (LwA) and presented in Decibels (dBA), the “A” represents a scale weighting which more closely represents the hearing of the human ear. 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. Sound Pressure (LpA) is also measured in decibels on an “A” weighted scale. However this value will vary dependent on location. When measured in an anechoic chamber the value will be lower, as some sound is effectively absorbed by the soundproofing material in the chamber. If measured in a hard chamber the value will be higher due to reflected noise adding to the total being measured. Hence Sound Pressure is not a good method to use as it can vary depending upon the type of measurement chamber. Where Sound Pressure is measured in an anechoic chamber the value in dB will be lower than the Sound Power value. This has lead to some confusion in the past and comparisons should not be made on an ad hoc basis between Pressure and Power. 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.

Sometimes the Consumers Organisations develop their own test methods but these are rarely proven by extensive ‘round robin’ tests and field correlation, as IEC tests are supposed to, and many manufacturers object to them! Some examples of such tests can be found in the UK Consumer’s Association developed test to measure the removal of pet hair from surfaces using actual pet hair, which is accepted by many as a useful test. Another is the use of actual household dirt in some cleaning tests by Stiftung Warentest.

1.3.4 International

There is one other major, international test organisation which has published extensive vacuum cleaner performance test methods and that is the US based ASTM International. These test methods and standards have been developed in the US but are increasingly being determined by European members of ASTM who are also on the IEC committees. The ASTM committee F11 which deals with these standards was originally established to provide test methods for labelling and found that some of the IEC test methods did not provide statistically acceptable results, hence they developed alternatives. In general these give similar results, in airflow measurements for example, but since they measure cleaning on four different carpets give differing results from the IEC single carpet test.

IEC 60312 has recently been republished as the 4th Edition and the EN document will be revised to reflect this. One major change is to include energy measurement, which links with the work being done by CENELEC TC59 WG6 who are developing a test methodology for a potential vacuum cleaner energy label (see Section 1.5 below). Another change has been to introduce a test method to measure performance when the dirt receptacle is filled. It should be noted that the actual word used in the standard is “loaded”, this does not represent any specific point during filling but simply gives a guide to performance during filling. There is no acceptable definition for “full”!

The 5th edition of IEC 60312 is currently being worked on and an initial Draft document has already been circulated. It is scheduled for publication in December 2009. Changes include new dust emission and filtration efficiency tests as well as improvements to air data measurement. It should be clear then that there are many changes being examined for new or modified performance test methodologies at this time and progress will be monitored.

In the United States customer pressure has driven ASTM and AHAM to start the development of energy measurement standards for implementation in 2009. There is a strong possibility that the energy measurement method will be that already included in IEC 60312 and EN60312 (Clause 4.14) 4th editions, possibly with different surfaces being used for the measurement. The method being developed by CENELEC WG6 for energy labelling purposes will also be examined, however it is possible that the “Energy Star” rating may be used as the method of indication to users that the product uses low energy.

1.3.5 Eco Approval Schemes

1.3.5.1 Allergies.

European Centre for Allergy Research Foundation (ECARF) Seal of Approval. This is a free issue seal of approval based on Manufacturers claims relating to filtration efficiency.

British Allergy Foundation Mark of Approval: this approval mark is awarded by the British Allergy Foundation. It uses actual allergens in a controlled manner to test how many are actually removed during a cleaning test.

1.3.5.2 EC Eco-Labelling Scheme

The existing criteria[4] valid from 1 April 2003 until 31 March 2007 with an extension to 31 March 2008. However, as there were no applications made for an Ecolabel, these vacuum cleaner criteria have now expired, and we understand that the European Commission has no plans to extend them.

Figure 1 - Extract of EC Ecolabel Criteria for Vacuum Cleaners[5]

ECOLOGICAL CRITERIA

Limitation of the use of substances harmful for the environment and health

- Plastic part < 25 g shall not contain:
  - Chloroparaffins with chain length 10-13 C, chlorine content > 50% by weight.
  - Flame retardants.
  - Substances assigned R45-46, R50-53, R60-61 in accordance with Directive 67/548/EEC.
- Except as allowed according to Directive 2002/95/EC, the product shall not contain:
  - Lead.
  - Mercury.
  - Cadmium.
  - Hexavalent chromium.
  - Polybrominated biphenyls (PBBs).
  - Polybrominated biphenyl ethers (PBBEs).

Dust removal efficiency	▪ 70% for carpet. ▪ 98% for hard floor.
Energy saving	▪ < 345 Wh for carpet. ▪ < 69 Wh for carpet. ▪ Suction Head Motion Resistance: <25 N.
Reduction of noise	▪ < 76 dBA.
Dust emissions	▪ < 0.01 mg/m³. ▪ Dust filters replaceable and/or washable and light-coloured.
User instruction for environmental use	The following information shall come with the product: ▪ Emptying bag when full decreases energy consumption. ▪ Switch off when not in use. ▪ Guarantee and availability of spare parts. ▪ Product designed to be recycled not dumped. ▪ Advice on take-back offer. ▪ Advice on maintenance (change bags, filters). ▪ Indicator to show when bag is full. ▪ Weight of product. The following information shall appear on the eco-label: ▪ Efficient cleaning, low dust emissions, low noise. ▪ Low energy consumption. ▪ Improved durability and recyclability.

Green design to facilitate recycling:

- Easy disassembly of the product taken into account in the design.
- Electrical parts mechanically connected.
- Metal parts easily accessible.
- Plastic parts with no metal inlays.
- Plastic parts > 25 g clearly identified according to standard ISO 11469.
- Manufacturer offers take-back and recycling (except for filters and bags).

DURABILITY CRITERIA

- Motor lifetime > 550 hours.
- Power nozzle lifetime > 1,000 drum rotations.
- Hose lifetime > 40,000 oscillations.
- On-off switch lifetime > 2,500 times.
- 2 year guarantee and replacement parts available for 10 years after production ceases.

1.4 Existing Policies and Measures (or Policy Instruments)

Legislation relevant to vacuum cleaners is summarised in Table 1 below.

Table 1- Existing Policies and Measures relevant to Vacuum Cleaners

No.	Description	Reference	Applicability	Link	Comment
1.3.1	**EU policies and measures**				
1.3.1.1	EU Energy label	In development?	All products		CENELEC TC 59 WG6 working on programme
1.3.1.2	EU eco-label	Voluntary (2003/121/EC)	Self contained vacs such as cylinders and uprights, does not cover cordless or battery operated products nor central vacuuming systems	http://ec.europa.eu/environment/ecolabel/product/pg_vacuumcleaners_en.htm	
1.3.1.3	RoHS	Mandatory (2002/95/EC)	All products		
1.3.1.4	WEEE	Mandatory (2002/96/EC, 2003/108/EC)	All products		
1.3.1.5	Noise	Mandatory (2000/14/EC - Noise Emissions for Outdoor Equiptment Directive)	Leaf suction machines used outdoors only		
1.3.1.6	Packaging	Mandatory (94/62/EC - Packaging Directive)	The packaging vacs are supplied in, if any		
1.3.1.7	Safety (electrical)	Mandatory (2006/95/EC -Low Voltage Directive)	All products		Harmonised standards cover emission of toxic material under fault (on fire) conditions. Directive otherwise deals just with safety
1.3.1.8	Safety (explosive atmospheres)	Mandatory (94/9/EC - ATEX Directive)	Only vacs formally certified by a notified body can be used in areas classified as potentially explosive		Equipment and protective systems intended for use in potentially explosive atmospheres.

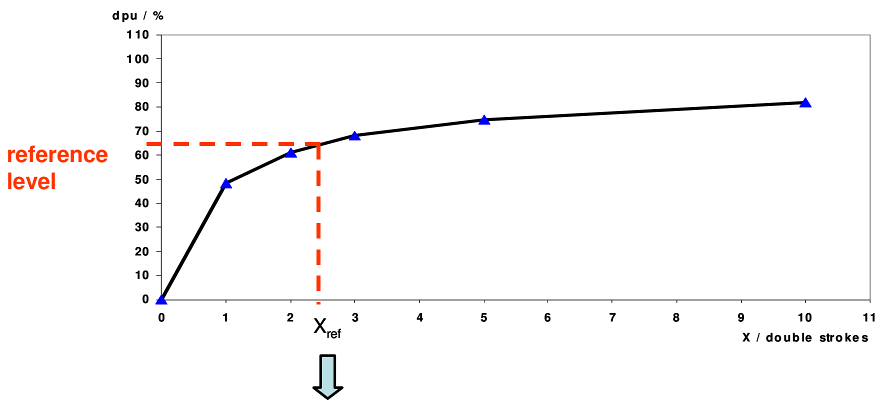
No.	Description	Reference	Applicability	Link	Comment
1.3.1.9	Built environment	Complicated but potentially mandatory (89/106/EC - Construction Products Directive)	(potentially) all products fitted into buildings e.g. centrally sited vacuum cleaning systems	_	
1.3.1.10	Electromagnetic Compatibility (EMC)	Mandatory (2004/108/EC - EMC Directive)	All products	_	
1.3.1.11	Chemicals	Mandatory (2006/121/EC - REACH)	Vacs supplied complete with chemical treatments	_	
1.3.1.12	Batteries	Mandatory (2006/66/EC - Batteries Directive)	Vacs supplied with battery powered heads	_	
1.3.1.13	Existing eco-design standards	None		_	
1.3.1.14	Minimum efficiency directives	None		_	
1.3.1.15	Product liability	None		_	
1.3.1.16	Industry voluntary commitments	None			
1.3.2	**Policies and measures in EU member states**				
1.3.2.1	National eco-label schemes	France			
1.3.2.2	National energy saving recommended schemes	None			
1.3.2.3	Swedish EPD scheme	Voluntary	Scheme is applicable to cylinders, may be open to other types too	http://www.environdec.com/reg/epde26e.pdf	
1.3.2.4	Economic incentives for efficient appliances	None			
1.3.2.5	Economic incentives for low allergen vacs	None			
1.3.2.6	National building regulations	Could be applicable in a number of EU countries	(potentially) all products fitted into buildings		
1.3.2.7	Additional local legislation	None			

No.	Description	Reference	Applicability	Link	Comment
1.3.2.8	Voluntary labelling schemes for low allergen or HEPA vacs	None			May be included on energy label
1.3.3	**Environmental policies and measures in non-EU countries**				
1.3.3.1	Australia and New Zealand	None			
1.3.3.2	USA and Canada	None			
1.3.3.3	China	None			
1.3.3.4	Japan	None			
1.3.3.5	Brazil	None			
1.3.3.6	Other countries	None			

1.5 Progress of CENELEC CLC TX 59X WG 6

1.5.1 Mandate M 353: Energy Labelling for Vacuum Cleaners

An amendment will be made to EN60312 following work on energy consumption and cleaning performance of vacuum cleaners. “Energy-efficiency“ will be defined as energy consumption necessary to reach a reference level of dust pick up (on carpet and hard floor). The diagram below illustrates this.



$$W_{(Xref)} = W_{(10m2)} / 5 * x_{ref}$$

[Diagram source: H. Schellenberger, BSH]

Filtration performance will be defined as “fractional filtration efficiency“, taking into account the dust entering and emitted by the vacuum cleaner. The result will be shown as percentage of retained dust. The medium used will allow consideration of particle sizes upto 4 microns.

The criteria for: useable size of dust receptacle, radius of operation, and supplementary information will be kept unchanged.

Currently, Ringtests are in planning. The procedure on how to do the measurements and the tests are described in detail, Wilton test carpets are available from a new supplier, costs are estimated and call for funding has been sent to the EU by CENELEC (currently awaiting response). The planned timescale for the amendments are for Ringtests to start in February 2008 with a view to final completion by November 2008.

1.6 Conclusions

All household and similar use vacuum cleaners will be considered for their usage of energy, effect on the environment, use of materials and disposability with consideration to cleaning performance and general use. Only specialist vacuum cleaners such as central vacuum cleaners and those designed for highly specialised tasks are excluded as they are small in number and do not easily correspond with general test procedures.

2 Task 2 Economic and Market Analysis

Economic and Market data on vacuum cleaners are important to understand because we need to identify the extent to which the market place is homogenous across the EU. This is key to ensure that any implementing measures do not disadvantage a particular MS or business sector.

2.1 Generic Economic Data

Eurostat provides the following data on production of domestic vacuum cleaners in the EU.

Table 2 – Domestic Vacuum Cleaners Production (000 units) ex PRODCOM

Nr.	Country	Year:	2000	2001	2002	2003	2004	2005	2006
1	France		-	-	-	-	-	-	-
3	Netherlands		-	-	-	-	-	-	-
4	Germany		6087	6536	4895	4361	4371	4812	5315
5	Italy		2609	2507	2616	2551	2963	2744	2498
6	United Kingdom		2491	2638	2454	2679	3682	1458	1831
8	Denmark		141	101	89	36	-	-	-
9	Greece		-	-	-	-	-	-	-
10	Portugal		-	-	-	-	-	-	-
11	Spain		-	-	-	-	-	-	-
17	Belgium		-	-	-	-	-	-	-
18	Luxemburg		-	-	-	-	-	-	-
24	Iceland		-	-	-	-	-	-	-
28	Norway		-	-	-	-	-	-	-
30	Sweden		1108	944	885	-	-	-	-
32	Finland		-	-	-	-	-	-	-
38	Austria		-	-	-	-	-	-	-
46	Malta		-	-	-	-	-	-	-
53	Estonia		-	-	-	-	-	-	-
54	Latvia		-	-	-	-	-	-	-
55	Lithuania		0	-	-	-	-	-	-
60	Poland		-	-	-	-	-	-	-
61	Czech Republic		-	-	-	-	-	-	-
63	Slovakia		-	-	-	-	-	-	-
66	Romania		-	-	114	-	-	-	-
68	Bulgaria		-	-	-	-	-	-	-
91	Slovenia		-	-	-	-	-	630	-
92	Croatia		-	-	-	-	-	-	-
600	Cyprus		-	-	-	-	-	-	-
1110	EU15TOTALS		16135	15346	13843	12129	12759	9383	-
1111	EU25TOTALS		-	-	-	15647	15713	13328	195
1112	EU27TOTALS		-	-	-	522	-	251	14046

Note: Table 2 has been created directly from the ProdCom data query system. It should be noted with care that the EU Totals figures exhibit some discontinuities, particularly for years 2003 to2006 data for EU-15, EU-25 and EU-27. The reasons for these are not apparent. However, the totals figures indicate a general decline in the numbers of vacuum cleaners produced in the European Union. The above data covers PRODCOM code numbers 29712113 and 29712115 (Domestic vacuum cleaners with self-contained electric motor for a voltage >= 110V and < 110V respectively).

Note: PRODCOM 2007 code numbers for vacuum cleaners are:

29712123 (Vacuum cleaners with a self-contained electric motor of a power <= 1500 W and having a dust bag or other receptacle capacity <= 20 l)

29712125 (Other vacuum cleaners) were identified, and

29713010 (Parts for vacuum cleaners)

Thus, it can be expected that production data for 2007 will differ from previous years due to these changes.

PRODCOM also provides information on the total value of production across the EU27 and the average unit values for these 2 product groups.

Table 3 - PRODCOM: Total Value of Production (million Euros) and Average EU27 unit values (Euros) – Domestic Vacuum Cleaners

	Product Groups (M Euros)			Unit Values (Euros)	
Year	29712113 value	29712115 value	Total Production Value	29712113 item	29712115 item
2006	1253	16	1268	101.98	79.94
2005	1222	16	1238	92.22	72.74

2.2 Market and Stock Data

2.2.1 Domestic Vacuum Cleaners

Data are also provided by PRODCOM on imports and exports of domestic vacuum cleaners.

Table 4 - Imports of Domestic Vacuum Cleaners (000 units) ex PRODCOM

Nr.	Country	Year:	2000	2001	2002	2003	2004	2005
1	France		4294	4549	4342	4897	6266	6188
3	Netherlands		2837	3420	4913	5863	5625	5165
4	Germany		5829	6200	7301	8393	10627	11718
5	Italy		2340	2451	2969	3517	5014	5024
6	United Kingdom		3807	4976	6621	8365	9956	8977
7	Ireland		269	293	358	398	410	462
8	Denmark		509	596	582	948	938	943
9	Greece		565	660	600	838	973	1103
10	Portugal		503	420	453	506	602	659
11	Spain		1860	1626	1746	2360	2901	2949
17	Belgium		2522	2886	3384	3763	3953	3763
18	Luxemburg		44	48	68	55	69	72
30	Sweden		853	835	888	1093	1202	1682
32	Finland		408	420	449	499	707	742
38	Austria		793	776	784	895	1164	1252
46	Malta		-	-	-	21	15	18

Nr.	Country	Year:	2000	2001	2002	2003	2004	2005
53	Estonia		45	53	55	63	64	82
54	Latvia		-	72	70	97	104	115
55	Lithuania		53	61	84	94	145	165
60	Poland		-	-	754	880	941	1045
61	Czech Republic		-	331	426	567	724	752
63	Slovakia		256	158	186	214	222	269
64	Hungary		-	439	538	597	676	725
66	Romania		-	-	191	27	56	68
68	Bulgaria		-	125	165	245	288	302
91	Slovenia		-	94	79	111	171	189
600	Cyprus		-	-	-	38	40	48
1110	EU15TOTALS		27435	30158	35460	42390	50405	50700
1111	EU25TOTALS		27789	31366	37652	45070	53508	54108
1112	EU27TOTALS		27789	31491	38008	45342	53852	54477

Table 5 - Exports of Domestic Vacuum Cleaners (000 units) ex PRODCOM

Nr.	Country	Year:	2000	2001	2002	2003	2004	2005
1	France		1455	1364	774	731	894	880
3	Netherlands		2056	1667	1973	1787	3431	2686
4	Germany		4690	4865	5048	5108	6117	6721
5	Italy		1897	1646	1631	1910	1807	1719
6	United Kingdom		3432	5122	787	755	707	651
7	Ireland		698	619	422	359	254	215
8	Denmark		332	355	281	322	319	226
9	Greece		28	16	17	83	119	87
10	Portugal		183	171	284	170	18	10
11	Spain		680	816	775	800	715	434
17	Belgium		2184	2176	2402	2650	2824	3104
18	Luxemburg		5	7	13	7	7	17
30	Sweden		1200	1070	1282	1290	950	527
32	Finland		85	129	154	209	281	314
38	Austria		308	277	233	215	333	447
46	Malta		-	-	-	0	0	0
53	Estonia		1	4	2	2	3	13
54	Latvia		-	7	12	19	16	12
55	Lithuania		1	2	7	3	8	10
60	Poland		-	-	938	874	1130	1050
61	Czech Republic		-	526	438	367	239	280
63	Slovakia		154	8	9	9	24	18
64	Hungary		-	1053	1659	1818	2119	2321
66	Romania		-	-	59	6	1	3
68	Bulgaria		-	3	2	1	3	1
91	Slovenia		-	735	897	904	843	703
600	Cyprus		-	-	-	0	0	0
1110	EU15TOTALS		19234	20300	16077	16395	18776	18038

Nr.	Country	Year:	2000	2001	2002	2003	2004	2005
1111	EU25TOTALS		19391	22635	20039	20393	23158	22445
1112	EU27TOTALS		19391	22638	20101	20399	23162	22449

Thus, at the overall European level, the apparent consumption of domestic vacuum cleaners (i.e. production + imports – exports) shows the following trends.

Table 6 - Apparent Consumption of Domestic Vacuum Cleaners (000 units) ex PRODCOM

Nr.	Country	Year:	2000	2001	2002	2003	2004	2005
1110	EU15TOTALS		24335	25203	33226	38124	44388	42045
1111	EU25TOTALS					40323	46063	44992
1112	EU27TOTALS		No data	No data	No data	No data	No data	No data

Table 6 shows there has been a major increase in the consumption of vacuum cleaners. Imports for most Member States have doubled in the period; exports about the same.

Consumption increases are most likely due to a combination of:

- Declining product lifetime
- Increase in multiple ownership

Falling lifetimes can be for many reasons including premature replacement of vacuum cleaners by owners who perceive their vacuum cleaner technology to be 'out of date'.

2.2.2 Commercial Vacuum Cleaners

Information on sales of non-domestic vacuum cleaners has been obtained from the first project questionnaire survey. Data is very limited.

Table 7 - Sales of Non-Domestic Vacuum Cleaners (2006)

	Total	Upright with bag	Upright bagless	Cylinder with bag	Cylinder - bagless	Wet/dry	Centralised	Tub[6]
France	115,000 (a) 70,000 (b)							
Germany	230,000 (a) 90,000 (b)							
Italy	20,000 (a) 10,000 (b)							
Spain	10,000 (a) 10,000 (b)							
Poland	30,000 (a) 10,000 (b)							
Scandinavia	40,000 (a) 30,000 (b)							
UK[7]	1,000,000	50,000				40,000	1000	750,000
EU25	**700,000 (a)** **300,000 (b)**							
Total EU27	**1,300,000**							

(a) = vacuum cleaners, (b) = wet/dry vacuum cleaners

[6] Includes both bagged and bag-less systems.
[7] Source: ICMMA

2.3 Market Trends - Background

2.3.1 Early vacuum cleaners

Self contained vacuum cleaners are a little over 100 years old, the first suction-only machines being invented and introduced by Hubert Booth into Europe in the early 1900s. His company eventually became known as Goblin. The next stage was the development of upright vacuum cleaners with a revolving brush to loosen debris. This was invented by James Murray Spangler and introduced by Hoover into the US a few years later.

In Europe, Electrolux (1908[8]), Vorwerk (1929[9]) and Miele (1931[10]) were all early entrants into the vacuum cleaner market.

2.3.2 Early development trends

The development of vacuum cleaners tended to be slow for the first 60 years, with vacuum cleaners in 1960 being clearly recognisable to the originals from the turn of the century. Performance was improved by further development of revolving brushes (agitators) and hygiene was improved by the introduction of the disposable paper bag soon after World War 2.

2.3.3 Wet and dry vacuum cleaners

In the 1960s Martin Miller, in the US, introduced the wet and dry pick up vacuum cleaner under the Shop Vac and Aqua Vac brands allowing liquids to be picked up for the first time. Around the same time professional cleaning of carpets was being introduced where liquids were dispensed onto surfaces and subsequently picked up by the same machine. This carpet washing was refined and introduced domestically by Alan Brazier in the 1980s under the Vax brand. In Europe this was the biggest revolution in vacuum cleaning since its introduction at the beginning of the 20th century, with Vax taking over half the UK market value with a single orange and black suction vacuum cleaner by the end of the 1980s.

Upright carpet washers or extractors were introduced into the US and Europe in the first years of the 21st century by Bissell and Hoover.

2.3.4 Cyclonic filtration bagless cleaners

James Dyson introduced the cyclonic filtration bagless vacuum cleaner, first to Japan, winning a prize in 1991[11], and then into the UK and Continental Europe under the Dyson brand in the 1990s. Following Dyson's successes, many other vacuum cleaner manufacturers introduced bagless vacuum cleaners, some with elements of cyclonic filtration and some with suitably positioned filters.

Bagless vacuum cleaners tend to predominate in the UK but bagged machines still command a large part of the market in other EU countries, such as Germany, for example. It should be noted that although Dyson machines are bagless, it is the cyclonic filtration system that sets them apart.

[8] http://www.electrolux.co.uk/node36.aspx?categoryId=5106 accessed 16 January 2008
[9] http://www.vkdirect.co.uk/AboutUs-VorwerkCompanyHistory.asp accessed 16 January 2008
[10] http://www.miele.de/de/haushalt/unternehmen/2335_4856.htm#p4848 accessed 16 January 2008
[11] http://www.dyson.co.uk/about/story/2kvacuum.asp

2.3.5 Other types of vacuum cleaner

Black and Decker introduced cordless hand held vacuum cleaners into the European market in the early 1980s.

2.3.6 Development of bags

Miele were among the first to introduce high efficiency filter media disposable bags, allowing bagged machines to maintain performance during filling.

2.3.7 Regional differences

In Europe, the UK generally preferred upright vacuum cleaners until the early 2000s, but by 2003 suction cleaners had overtaken upright cleaners in volume sales[12]. Continental Europe historically prefers suction cleaners. Lightweight suction cleaners mounted on a handle with integrated cleaning head (stick cleaners) also tended to be found more in Continental Europe than the UK.

2.3.8 Increase in power consumption

With plastics taking over from metal during the 1970s and electric motor developments allowing large input wattage claims, manufacturers have developed products with higher and higher input wattage. These have been marketed to consumers on the basis that the higher the wattage the better the product cleans to the point that consumers now associate power rating with cleaning efficiency. Input wattage values up to 2700 watts have been found in the European vacuum cleaner market.

Analysis of Which? Magazines (publications of the UK Consumer Testing organisation) that contained vacuum cleaner tests reveal how input power ratings of vacuum cleaners have increased over the last 40 years or so. The 1960 report showed that tested products had an average wattage of 400 W, with a range of 150 to 950W. By 1978, typical wattages of each type of vacuum cleaner were:

- hand held up to 300W
- cylinder around 650W
- cannister 500 to 1100W
- upright 300W
- stick 450W

Information obtained from retail catalogues[13] confirm the trend:

Type	Input Power Range 2003	Input Power Range 2008
Bagged upright cleaners	1300 to 1800 Watts	1150* to 2000 Watts
Bagless upright cleaners	1450 to 1700 Watts	1000** to 2000 Watts
Bagged cylinders	1100 to 1800 Watts	1200 to 2500 Watts
Bagless cylinders	1400 to 2000 Watts	1400 to 2400 Watts

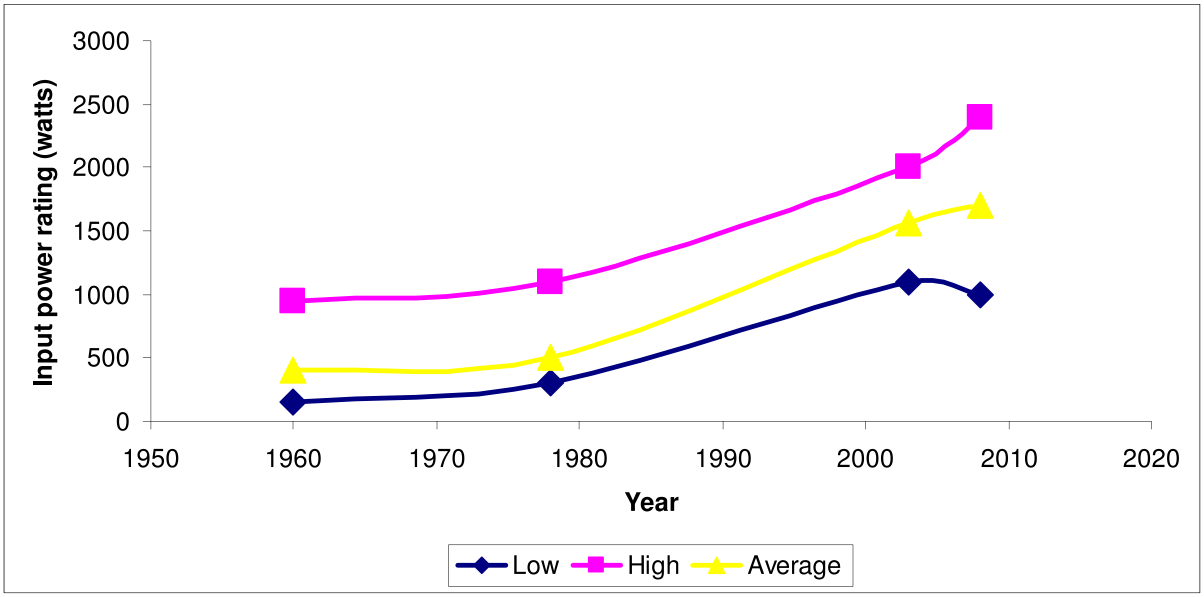
* - Sebo model only. The rest surveyed were in the range 1700 to 2000 watts.

** - Morphy Richards low energy Storm model only. The rest were in the range 1400 to 2000 watts.

The above data can be illustrated graphically as below.

[12] Mintel August 2006 Vacuum Cleaners Market Intelligence.
[13] Argos catalogues Spring/Summer 2003 and 2008.

Figure 2 - Increase in Input Power Rating over Time



This trend towards increasing input power rating in recent years is confirmed by Dutch Trade Association[14] annual overview reports, which show increasing proportions of vacuum cleaner sales for cleaners over 1800 watts (see table below)

Table 8 - Percentage of Vacuum Cleaner Sales rated over 1800 Watts

Year	2003	2004	2005	2006	2007
>1800 W	8%	14%	18%	28%	39%

(Extracted from Vlehan Overview Reports)

2.3.9 Cleaning performance

Historically upright cleaners performed better than suction cleaners, but some, more expensive suction cleaners have motorised cleaning heads with agitators, which can improve their performance compared to upright cleaners. Stick cleaners with motorised cleaning heads, also found in Continental Europe, narrow that difference even further in the sense that they are almost true uprights.

2.3.10 Motors

Electric motors used in vacuum cleaners are beginning to change as we move into the 21st century, having remained the same for almost 100 years. Electronics have been used to control motor speeds and power for around 35 years and some have even used feedback from the suction head to modify suction power dependent upon dirt entering the machine or the "clogging" of bags or filters. Hence if sensors detect dirt being picked up then motor power is increased until no more dirt is detected. Equally if bags or filters become clogged the power can be increased to compensate.

The motors themselves have remained the same however, and rely on carbon brushes to supply electrical power to the rotating armature. These carbon brushes tend to wear down and this wearing down means there is a finite life to the motor, usually more than 500 hours which is equivalent to around 10 years use in a typical home. Some commercial cleaners will run for up to 1500 hours before the brushes wear out. Typically a domestic vacuum cleaner motor cannot be serviced and at the end

[14] www.vlehan.nl

of the brush life the motor has to be thrown away. With commercial vacuum cleaners many can be serviced and new brushes fitted, thus extending the life of the motor and of the vacuum cleaner.

More recently a new generation of electric motors has begun to appear; these do not have carbon brushes and use pure electronic control to provide the electrical field which will drive a permanent magnet rotor without physical contact. These motors will have extended lives and ultimately this life will depend on the reliability of the rotor bearings rather than the wearing down of carbon brushes. These motors can be smaller and can run at extremely high speeds (up to 100,000 rpm compared with approximately 30,000 rpm for carbon brush motors).

Until recently, vacuum cleaner manufacturers typically made their own motors, but today it is increasingly common for specialist companies to manufacture them.

2.4 Market Trends – Current Status

2.4.1 Market saturation

By most definitions the EU vacuum cleaner market is saturated and many homes in Europe will have more than one vacuum cleaner.

2.4.2 Main market players

Dyson, Vax, Electrolux, Hoover, Miele, Siemens, Rowenta and Philips are probably the main market players. (Vax are part of TTI, the world's largest vacuum cleaner manufacturer). Additionally, brands from the Far East have produced products for the EU market, including LG, Panasonic and Samsung. Own brand products sold by retailers also have a part in the EU market.

2.4.3 Production structure

The majority of vacuum cleaners are now manufactured in China, the larger players using their own Chinese-based manufacturing facilities, but many simply purchase from OEM companies. There is relatively little manufacture in Western Europe, however Numatic currently makes around 10,000 vacuum cleaners per week in the UK. Miele still manufactures a large number of cleaners in Germany, although automated manufacture features highly in this. Chinese or Hong Kong based companies have also moved outward and currently TTI (Hong Kong) owns the Royal, Hoover (US), Dirt Devil and Vax brands making them the largest manufacturer of vacuum cleaners in the world.

- Dyson manufactures in Malaysia.
- Electrolux manufactures in China, Mexico, US and Europe
- Miele manufactures in Germany
- Vax manufactures in China, Mexico and the US
- Hoover (Europe) manufactures in China

2.4.4 Consumer tests

IEC-based CENELEC performance standards are accepted in Europe, with the Advertising Standards Authority in the UK stating that IEC standards should be used when advertising performance claims in the UK. Consumer organisations largely use IEC-based standards and use laboratories such as SLG in Germany to undertake Europe-wide testing for them. Some consumer organisations use test methods developed by themselves, for example Consumers Association in the UK uses a test measuring pet hair pick up using real pet hair and Stiftung Warentest in Germany has used real household dirt in some testing.

There has been some friction over the years between manufacturers and consumer organisations when test methods have been developed unilaterally by consumer organisations. However, these test methods were usually developed because there was not an appropriate IEC or CENELEC test method and this has tended to drive the subsequent inclusion of the test in an official international test method.

Currently there is an increasing liaison between IEC and ASTM (US vacuum cleaner performance tests are produced by ASTM and they do not use IEC methods generally). Some emissions tests are now being jointly developed by IEC and ASTM

2.4.5 Product trends

There is a trend towards the development of bagless vacuum cleaners with high input power and low selling prices to consumers. The input power is often used in marketing claims to indicate how 'powerful' the cleaner is and thus persuade consumers that it will perform better than one with a lower input wattage.

Bagless vacuum cleaners are sometimes seen as unhygienic. New tests are driving products to have lower dust emissions, including during emptying. Self-sealing disposable containers may increase in popularity.

Cordless vacuum cleaners that offer performance equivalent to mains powered models may soon be available. These will use less energy than mains models, without any loss of cleaning performance.

More users tend to have multiple vacuum cleaners, using each one for special areas or tasks within the household. So, for example, there could be an upright for downstairs, a smaller suction vacuum for upstairs, a cleaner for use in the garage and a hand-held for quick cleaning indoors.

As sales of vacuum cleaners have increased it is possible that the working life of the products has declined from over 8 years to around 4 years. However, in the multiple ownership scenario it is not clear how the lifespan is affected by households having multiple units.

New product development has been slow in recent years. However, carpet washing extractors have been marketed in the UK.

Some emphasis is noticeable on products designed to be easier to use, either in terms of ergonomics or additional features and tools.

Lower noise emission has been a focus for some manufacturers.

2.4.6 Consumer Expenditure Base Data

A Discount rate of 5% will be assumed and an electricity price of 0.15 Euro/kWh will be taken[15]. The product life for vacuum cleaners has been estimated at 8 years[16].

2.4.6.1 Average product price – low, mean, high.

Average product prices for 2006 in ProdCom were ~102 Euro (29712113) and ~80 Euro (29712115). These were considered to be inaccurate, the upper figure being too low: the lower figure being too high[17]. It is proposed that the following data is used from the MEEUP product study[18] for vacuum cleaners:

Average product price – EU product price average 125 Euro, low 98 Euro from Germany 2005, medium 123 Euro from the Netherlands 2003 and high 200 Euro from Germany 2005 figures.

2.4.6.2 Consumption of bags, filters and other accessories per year and cost.

Consumption of bags, filters and other accessories per year and cost – five bags and one filter, cost 12 Euro.

[15] Based on uswitch.com best deal for average household consumption of 3000 kWh per month.
[16] For UK vacuum cleaners, the average lifespan (after rationalising ownership and volume of sales data) was estimated by the Market Transformation Programme to be 7.8 years.
[17] General consensus at the First Stakeholder Workshop, 1st February 2008.
[18] MEEuP Product Cases Report, Final, 28/11/2005, VHK for the European Commission.

2.4.6.3 Estimate of repairs per year and average repair cost.

A survey of members of the UK consumer organisation Which? about product reliability showed that at least 1 in 5 upright vacuum cleaners in the survey required repair during the first 6 years, compared with around 1 in 10 for suction models[19]. The top three reasons for the repair of upright cleaners were - split/broken hose - 21% of breakdowns, suction - 19% of breakdowns, motor - 16% of breakdowns. For suction cleaners the most frequent reasons were - split/broken hose - 25% of breakdowns, suction – 15% of breakdowns, broken casing – 11% of breakdowns, power cable – 11% of breakdowns

The MEEUP study for vacuum cleaners assumed that 50% of vacuum cleaners were taken for repair during their product life, which was estimated as eight years. The Which? survey suggests that only 10 to 20% of vacuum cleaners are repaired in the first six years of their lifespan. Responses to our first questionnaire tended to agree with this estimate. It is therefore suggested that for this project the figure of 20% is used for the number of cleaners ever taken for repair in their lifespan.

The cost of repair is estimated at 50 Euro per repair, or 10 Euro per product. (averaged over all products).

[19] https://www.which.co.uk/reports_and_campaigns/house_and_home/Reports/cleaning/Cleaning%20appliances/Vacuum%20cleaners/Vacuum_cleaners_essential_guide_574_70328_5.jsp The total sample size for uprights was 3854 and the average score was 79%. The majority of respondents owned Dyson cleaners. For suction the sample size was 3062 and the average score was 93%.

3 Task 3 Consumer Behaviour and Local Infrastructure

3.1 Real life usage

3.1.1 Ownership

Ownership of vacuum cleaners may vary across the EU. There are no published data that compare all 27 countries.

The following table is drawn from searches of different country household budget surveys and official statistical sites[20]. The most recently available year is given.

Country	% ownership	Year
Belgium	C 95%	2004[21]
France	c. 90%	2006[22]
Ireland	95.5%	2004-2005[23]
Netherlands	99.6%	2000[24]
Poland	94.2%	2006[25]
Portugal	67.4%	2003[26]

In some countries, the ownership is in excess of one vacuum per household that has a vacuum cleaner. For example, in the UK ownership is likely to be in the region of 1.5 per household as consumers have bought separate cleaners for different floors in their home or for different functions such as use in a garage or wet and dry cleaning. Many homes also have a hand held battery cleaner. The overall time spent cleaning the home is unlikely to vary from the total suggested below. However the multiple number of cleaners should be considered in the sensitivity of the manufacturing and waste projections.

3.1.2 Time spent cleaning

An average of 70 minutes per week or 60 hours per year was given in the MEEUP study on vacuum cleaners for the Netherlands[27].

UK sources suggest that this figure of about one hour is also reasonable for the UK for household cleaning[28].

Miele suggest that their carbon filters are changed after one year or fifty hours cleaning[29]. This suggests an hour per week is a reasonable average.

As discussed in the MEEuP study on vacuum cleaners, the amount of time spent cleaning may depend on the size of the dwelling, the amount and type of dirt, the surfaces being cleaned, the effectiveness of the cleaner and the hygienic standards of the user. In practice, however, the time available for cleaning is at least as important.

The Swiss TopTen website for vacuum cleaners calculates annual running costs on the basis of cleaning 150 m^2 twice per week[30]. They do not indicate how long this might take.

[20] Countries checked but data not found: Denmark, Finland, Germany, Greece, Italy, Norway, Sweden, Spain, United Kingdom, Latvia, Estonia, Lithuania, Slovenia, Austria, Romania, Bulgaria, Bosnia, Czech, Ukraine, Belarus, Serbia.
[21] Belgium 2004 Dossier seniors Profil des seniors: qui sont-ils ? Comment vivent-ils? http://statbel.fgov.be/press/pr109_fullreport_fr.pdf
[22] France: Enquête Budget de famille 2006 http://www.insee.fr/fr/ppp/ir/BDF06/dd/excel/BDF06_D4.xls
[23] Ireland: Central Statistics Office 2007 *Household Budget Survey 2004-2005* http://www.cso.ie/releasespublications/documents/housing/hbsfinal/text.pdf
[24] VHK 2005 MEEuP Product Cases Report Vacuum Cleaners page 7.12
[25] Poland: Household Budget Surveys in 2006 http://www.stat.gov.pl/cps/rde/xbcr/gus/PUBL_household_budget_surveys_in_2006.pdf
[26] Statistical Year Book of Portugal 2004 http://www.ine.pt/ngt_server/attachfileu.jsp?look_parentBoui=13847047&att_display=n&att_download=y
[27] VHK 2005 MEEuP Product Cases Report Vacuum Cleaners page 7.12
[28] MTP BNXS30 Vacuum cleaners http://www.mtprog.com/ApprovedBriefingNotes/pdf.aspx?intBriefingNoteID=344
[29] Miele UK website accessed 1 May 2008 https://www.miele.co.uk/accessories/Details.aspx?rdid=5&aid=424

It is suggested at this stage that an average of one hour per week is used for cleaning time, with a 'light' pattern of 15 minutes per week, and a 'heavy' pattern of four hours per week.

3.1.3 Power measurement

Many cleaners have controls for consumers to adjust power consumption. Instruction books may recommend that the power consumption is adjusted if the cleaner is to be used for a long period of time to prevent the motor overheating or if the user is cleaning more delicate fabrics, such as curtains, that might be sucked into the nozzle. There are no data available on whether consumers take notice of these recommendations. In any case, the majority of regular cleaning is likely to take place at full power.

Other cleaners may automatically adjust the power consumption depending on the floor surface being cleaned. Consumers may or may not choose to use this function on their cleaners.

In recent tests Which? found that the average energy consumption was around 260Wh to vacuum a $10m^2$ area of carpet at full suction In the April Which? 2008 test consumption ranged from 176 to 342Wh[31].

The average power consumption of 1500W from Task 2 will be used as a typical input power for a domestic vacuum cleaner (slightly less for a commercial cleaner – 1100W).

3.1.4 Auxiliary inputs – bags, filters and belts

Bagged vacuum cleaners require the bag to be changed to prevent a reduction in cleaning performance. The frequency of changing will vary depending on the type and amount of dirt collected by each bag and the perception of the user of the need for changing. For example, if high amounts of very fine particles such as plaster dust are collected it is usually recommended that the bag is changed sooner than if an equivalent quantity of normal household dust is collected, because the fine particles block the air flow through the bag. Many models indicate when the bag should be changed, but consumers may choose to change the bag more or less frequently than the machine indicates.

Where manufacturers offer free bags with products or schemes to supply them with extended warranties they usually offer 10 per product per year[32]. It is therefore proposed that 10 bags per year are used by each bagged cleaner.

Filters are required to prevent dirt reaching the motor and to prevent small particles returning to the room in the exhaust air. For bagged cleaners, there is often a set of filters supplied with a set of bags and it is recommended that the filters are changed when the first bag is used. If filters are not supplied with bags, manufacturers typically recommend that the filters are changed, although this can very from annually (Vax) to every two months (Oreck).

It is proposed that one set of filters is used by each cleaner per year.

Consumers may also choose to use filters with a higher extraction level than those originally supplied with their machines. The frequency of changing these may vary from the recommended time because users extend the time needed because of the cost of these items or change more frequently because they are concerned about health issues such as allergies and asthma.

It is proposed that one filter per year is used for a small proportion of the market, perhaps 10%.

Carbon filters are sometimes chosen for their ability to remove odours. These are usually recommended to be changed every six months (Bosch[33]) or annually or after 50 hours (Miele[34]).

It is proposed that one filter per year is used for a small proportion of the market, perhaps 10%.

[30] Swiss TopTen criteria for vacuum cleaners http://www.topten.ch/index.php?page=auswahlkriterien_staubsauger&fromid=
[31] Which? website accessed 2 May 2008 http://www.which.co.uk/reports_and_campaigns/house_and_home/Reports/cleaning/Cleaning%20appliances/Vacuum%20cleaners/Vacuum_cleaners_essential_guide_574_70328_7.jsp
[32] Electrolux website accessed 1 May 2008 http://www.electrolux.co.uk/Files/United_Kingdom_English/Files/Electrolux07_SpecBrochure_8pp.pdf
Miele UK website accessed 1 May 2008 http://www.miele.co.uk/Resources/CustomerSupport/GuaranteesWarranties/Vacuum_Guarantee.pdf
[33] Bosch UK website accessed 1 May 2008 http://www.bosch-eshop.com/eshop/bosch/gb/article426967.htm
[34] Miele UK website accessed 1 May 2008 https://www.miele.co.uk/accessories/Details.aspx?rdid=5&aid=424

Manufacturers also supply washable pre-motor and exhaust filters or filters that are described as 'self-cleaning', where the user can use the vacuum cleaner to clean the filter, or 'lifetime' where they do not require cleaning. These are unlikely to be replaced unless they are damaged.

Upright cleaners may require the drive belt to be changed if it becomes slack or breaks. Anecdotal evidence suggests this is unlikely to occur during the lifespan of the appliance (if it is as short as 4 to 5 years), and in the case of cheaper appliances may be the cause of the unit's disposal at this point. The belt is sometimes covered under the product guarantee, as in the case of Sebo, who offer a 5 year parts and labour guarantee on all domestic machines in the UK which includes the drive belts on upright machines[35].

For the more expensive appliances, the belt may be replaced but it is suspected that even a proportion of them will be replaced if the belt breaks. Belts are available from various spares outlets but are seldom stocked by High Street retailers, the delay in delivery may be sufficient to encourage replacement of the cleaner by the user.

3.2 End-of-Life behaviour

Consideration of end-of-life behaviour involves the identification of actual consumer behaviour (average EU) regarding end-of-life aspects. Some of the items discussed below will have already been introduced from a cost angle in the consumer expenditure section of the Task 2 report.

3.2.1 Product Lifetime

It is important to be very clear on the definitions of lifetimes, i.e.

- Economical lifetime / Planned Lifetime (Manufacturer, in product design specification)
- Service lifetime (i.e. when the product is actively used), and
- Lifetime to disposal (the product may spend some time in storage not being used prior to disposal)

Most useful for this preparatory study is the service lifetime (as this reflects the duration in which the product is mostly using energy). The typical service life of vacuum cleaners has been quoted as high as around 10 years and as low as 6.3 years. A figure of 8 years is suggested to accommodate these longest and shortest lifespans[36].

3.2.2 Repair and Maintenance Practice

A Which? Survey in 2008 showed that cylinder vacuum cleaners were more reliable than uprights[37]. At least one in five uprights up to six years old required repairs. Top reasons for breakdowns were as follows:

Reason for Breakdown	Upright - types	Cylinder - types
Split/broken hose	21%	25%
Suction	19%	15%
Motor	16%	-

[35] Sebo UK website accessed 1 May 2008 http://www.sebo.co.uk/Pages/aftercare.html
[36] See Task 2 Report and http://www.mtprog.com/ApprovedBriefingNotes/PDF/MTP_BNXS30_2008February11.pdf.
[37] Which? January 2008.

Broken casing	-	11%
Power cable	-	11%

Note that this survey only covered branded products, it did not cover the own brand products from supermarkets, catalogues and catalogue stores etc., which due to their budget, low-price nature may be more likely to fail. (In 2006 GfK hitlists recorded 40% of UK sales as Tradebrand which are either branded models that are exclusive to a particular retailer or retailer own brand models, the next most important brands were Dyson 14%, Vax 10% and Electrolux 6%).

Most manufacturers provide spare filters with their new products. Presumably, the reason for this is to provide extra stimulus for regular filter change. Although we have found no evidence[38], it is possible that failure to replace filters could reduce product life. Reduced air flow past the motor could lead to overheating of the motor. However, in the event of the filters simply becoming blocked gradually, then the load on the motor will also reduce as the airflow is reduced, this may compensate for the reduction in cooling effect.

3.2.3 Reuse, Recycling and Disposal

Reuse

Overall 40,000 people work in Social Organisations throughout the EU. 17,000 people collect, repair and recycle 300,000 tonnes of WEEE through 1,200 centres[39]. This represents about 4% of the estimated WEEE arisings in the EU27. Given that the main focus of reuse activity in this area is predominantly towards repair of washing machines and fridges, it can be assumed that opportunities for reuse of vacuum cleaners are limited to second life reuse (e.g. vacuum cleaner is used by the owner for another purpose such as car valetting/cleaning).

Consumer Behaviour for EOL Equipment

Take-back schemes for WEEE items are being established in both the EU Member States and other European countries. These are usually based on the provision of collection points by municipal authorities (sometimes, retailers can take items that they collect to these collection points), and the take-back schemes arrange for the collected materials to be recycled (according to the requirements of the WEEE Directive). Many of the European collection schemes are focusing primarily on achieving the 4 kg/inhabitant/year target, but appear to be comfortably exceeding this. For example, collection schemes in Norway, Sweden and Switzerland are currently collecting over 10 kg/person per year of WEEE items. European householders tend to recycle as the norm – the recycling of small WEEE is seen as a normal part of this behaviour. Education/promotional campaigns are important for raising awareness, but where they are required they are usually targeted at WEEE in general, rather than at small WEEE. The use of incentives to encourage householders to submit their small WEEE for collection appears to be unnecessary. Householders' normal behaviour is to recycle wherever it is possible to do so[40].

In terms of disposal behaviour, vacuum cleaners are generally too large to be disposed of with the normal household waste. Consumers will tend to take EOL vacuum cleaners to a household waste collection centre, which may or may not provide facilities for the separate collection of WEEE (waste electrical and electronic equipment). An analysis of the results from a number of pilot collection trials at household waste centres in the UK[41] showed that Category 2 (small household appliances) equipment collected was dominated by vacuum cleaners.

Table 9 - Weight Proportions of Collected Category 2 Equipment

Item	Average Weight %
Vacuum cleaners	**48.8%**

[38] Many machines are only used for between 3 and 5 years could be the reason not to have much data on failures.
[39] Craig Anderson, Re-use and Recycling: European Social Enterprises, FRN – UK, October 2006.
[40] Environment Agency, "Consumer Behaviour in Relation to Small Household WEEE", R2239, AEA Technology, July 2006.
[41] Environment Agency, "Information from Local Authority WEEE Collection Trials", AEA Technology, May 2004

Item	Average Weight %
Irons	**5.2%**
Toasters	**4.3%**
Fryers	**4.3%**
Kettles	**5.2%**
Coffee machines	**1.7%**
Electric knives	**0.4%**
Hair dryers	**5.2%**
Clocks	**0.9%**
Electric scales	**1.3%**

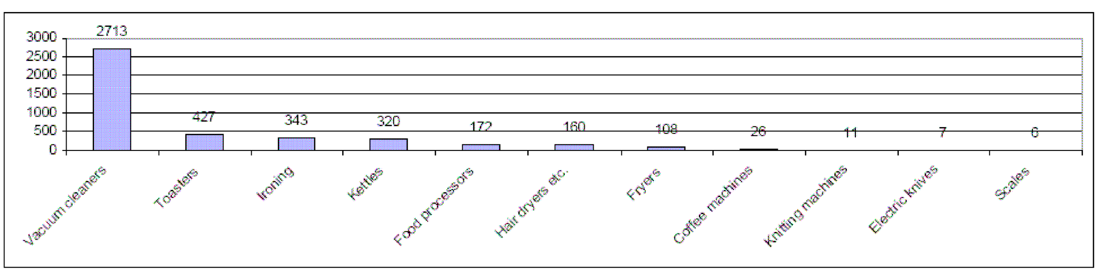
More recently, a set of trials were conducted to establish protocols for WEEE collections[42]. This study involved the hand sorting of 125 tonnes, made up from 16,401 individual items, of small mixed WEEE (SMW). The items were segregated into 10 categories, provided in the WEEE Regulations, and counted and weighed. Each segregated SMW category was homogenised by processing through a WEEE plant or a shredder/fragmentiser. Samples of the mixed output streams from these processes were handsorted to characterise and determine their compositions.

The Category Protocol values of SMW were established as:

- 10.3% - Category 1
- 19.9% - Category 2
- 22.7% - Category 3
- 22.2% - Category 4
- 2.0% - Category 5 – This household source is to be included as Non -WEEE
- 10% - Category 6
- 0.3% - Category 7
- 0.7% - Category 9
- 12% - Non-WEEE and unallocated

The analysis of the Category 2 element of small mixed WEEE confirmed that vacuum cleaners dominated this waste stream.

Figure 3 - Category 2 Analysis - Small Household Appliances



The average separate collection rate for Category 2 equipment has been estimated at 0.42 kg/inhabitant/year[43]. Based on a 2006 population estimate for the EU27 of about 492 million, this equates to about 205,000 tonnes collected. Thus on the basis of Table 9 above, the amounts of EOL vacuum cleaners collected is about 100,000 tonnes per year. The average weight of EOL domestic vacuum cleaners was determined as 7.2kg[44], therefore indicating that around 14 million EOL domestic

[42] CIWM(EB)/DEFRA, "Trial to establish WEEE protocols", Mayer Environmental, January 2007.
[43] European Commission, "2008 Review of Directive 2002/96 on Waste Electrical and Electronic Equipment (WEEE)", UN University, August 2007.
[44] Defra, "WEEE and Hazardous Waste: Part II", AEA Technology, R2233, June 2006.

vacuum cleaners are collected annually in the EU27 (this would represent about 30% of the number of vacuum cleaners sold in Europe annually – ref. Task 2 report).

3.2.4 Second Product Life

This is very difficult to quantify because the item is not considered either EOL or a waste but has been transferred to a second use application by the owner. Probably, the difference between service life and manufacturers design lifetime could be used as an indicator of the extent to this practice.

3.2.5 Best Practice for End-of-Life

Best practice for end-of-life has to take into account best practice in sustainable product use. Given that average input power ratings for vacuum cleaners have increased steadily over the last few decades, there is currently no justification for early product replacement for reasons of improved energy efficiency. Thus a long product life would not be detrimental for the environment[45].

Once EOL is reached, then the broad aim of the WEEE Directive is to address the environmental impacts of electrical and electronic equipment when it reaches the end of its life and to encourage its separate collection, subsequent treatment, re-use, recovery, recycling and environmentally sound disposal. It seeks to improve the environmental performance of all operators involved in the lifecycle of EEE. This directive sets targets for the separate collection of WEEE (currently 4 kg/inhabitant/year) and targets for the recovery (currently minimum of 70% by an average weight per appliance for category 2 equipment) and the reuse and recycling (currently a minimum of 50% by an average weight per appliance for category 2 equipment) of this collected WEEE. The European Commission is currently (Spring 2008) consulting widely on possible changes to targets as part of their review of the WEEE Directive. The suggested changes, which are ‘out for consultation’ are:

- Increase the current targets, for all or some categories;
- Introduce a target for category 8 equipment (medical devices);
- Material based targets for all WEEE or per product category;
- Stimulation of outlet market for recycled and recovered products, in particular for encouraging high level of material re-application.

The consultation closes in June 2008. It remains to be seen which improvement option(s) are most favoured.

3.3 Local infrastructure

3.3.1 Energy supply

Given that vacuum cleaning can be undertaken at any time of the day, short term interruption of the power supply is unlikely to affect overall consumer behaviour. Local tariffs aimed at shifting consumer use to off peak demand times are unlikely neither to affect the amount of domestic vacuum cleaning undertaken nor to influence the time of day that it is done. Vacuum cleaners are often considered to be noisy appliances, so it is unlikely that much cleaning is done when the rest of the household is asleep. Non-domestic cleaning such as offices and schools is likely to take place when the day-time workers are not present.

3.3.2 Physical environment

As mentioned above, there is some evidence that in some countries households own more than one vacuum cleaner. This may not influence the total amount of cleaning, but each type of cleaner may be

[45] European Commission, MEEuP Product Cases Report, VHK, November 2005.

used for specific tasks, i.e. cleaning carpet or hard floors; or for a specific area of the house i.e. one cleaner used for upstairs and another one for downstairs.

It is unlikely that many households habitually share vacuum cleaners for regular cleaning. They are typically a relatively cheap appliance that can be bought very easily for relatively small amounts of money. However, some of the more expensive appliances, for example wet/dry types suitable for carpet cleaning which are used on an infrequent basis may be shared between households, such as parents and children.

Spare parts are typically available through local retailers or via on-line suppliers. As noted above and in Task 2, however, it is believed that the level of vacuum cleaner repair is currently around 20% of all cleaners being repaired in their lifetime. The cost of spare parts is usually quite low, but unless there is a tradition of vacuum cleaner repair by owners in a particular country, the likelihood of it occurring is low.

Repair services are provided by some manufacturers in some countries, either directly or via third party companies. Examples from the UK demonstrate why many owners may opt to replace a product if it breaks down outside the guarantee, rather than pay for regular servicing or repairs. In the UK, Dyson offer guarantees, up to 5 years on new products in the UK for “The repair or replacement of your machine if your machine is found to be defective due to faulty materials, workmanship or function within 5 years of purchase”[46]. Dyson also offers a service package for products outside of the guarantee period and charges £65 (~90 euros) including VAT for labour and parts[47]. It does not give the price of spare parts for repair. Hoover charges £68.50 (~92.50 euros) for labour to repair an out of guarantee product and parts will be charged separately if used[48]. Consumers are therefore faced with the option of a repair to a relatively old machine that might cost more than the price of a new vacuum cleaner or buying a new cleaner. They may consider that they have had the vacuum cleaner for a reasonable amount of time and opt for buying a new cleaner.

Local independent businesses may specialise in the repair of domestic appliances. The range of repairs that they can complete will depend on the range of parts that is supplied by the different manufacturers. The cost of the repairs must also be low enough to encourage owners to seek a repair rather than replacing the product. These businesses may also offer servicing and their prices are likely to be lower than those charged by manufacturers[49].

The cost of vacuum service and repair could also be considered in the context of repairs and services for other domestic appliances and cars. For example, average repair costs for a washing machine in the UK were £77 (~105 euros) in 2005[50] and an interim car service by a multinational company in the UK would cost around £80[51]. (~110 euros)

Vacuum cleaners were identified as one of the domestic appliances that UK consumers would like to see having a longer lifespan[52], but their unwillingness to seek a repair, or inability (for whatever reason) to repair products themselves is acting against this desire.

[46] Dyson UK website accessed 1 May 2008 http://www.dyson.co.uk/support/help.asp?article=1098&product=DC19
[47] Dyson UK website accessed 1 May 2008 http://www.dyson.co.uk/support/help.asp?article=65&product=DC19
[48] Hoover UK website accessed 1 May 2008 http://service.hoover.co.uk/repair/OutOfGuarantee.aspx
[49] http://www.thameselectronics.co.uk/services/ quoted £35 for a service on 2 May 2008
D&D Electrical, Solihull quoted £18 plus parts and VAT for a service on 2 May 2008
Watts Electrical, Derby quoted £38 for a service on 2 May 2008.
[50] Which? June 2006 survey of Which? members in 2005
[51] Kwikfit website 2 May 2008 Ford Focus interim service £79 http://www.kwik-fit.com/mot-and-service-pricing.asp
[52] Cooper T and Mayer K 2000 *Prospects for Household Appliances* http://research.shu.ac.uk/csc/docs/Commsumm.pdf

4 Technical Analysis of Existing Products

This chapter contains all the technical inputs for the MEEUP model for each of the vacuum cleaner types in this study. This comprises the production phase (materials), distribution, In use phase (energy and maintenance costs) and end of life phase.

4.1 Production Phase

The material composition of vacuum cleaners is presented in the following Bills of Materials (BoMs) provided either by manufacturers and or by disassembly of certain products. Anonymous and averaged BoM data is presented in order to protect the confidentiality of those manufacturers who provided data.

The data will be used in the definition of the Base Case models and the evaluation of best available technologies (BAT).

The detailed Bill of Material (BOM) data lists all materials, by weight, for each base case vacuum cleaner. The base case is seen as being representative of current “best sellers”. The method of derivation varies for each type, but is generally based on an average of real models, with some parameters adjusted to be more widely representative of all models. An example of an upright vacuum cleaner is presented in Table 10.

Table 10 - BoM Example of an Upright Vacuum Cleaner

Nr	Component	Weight in g	Material category
1	Handle	600	1-BlkPlastics
2	Main upright housing	800	1-BlkPlastics
3	Cord hook swivel	10	1-BlkPlastics
4	Lower cover	250	1-BlkPlastics
5	Dirt receptacle cover	500	1-BlkPlastics
6	Bag retainer	30	1-BlkPlastics
7	Duct cover	30	1-BlkPlastics
8	Bag collar	7	7-Misc.
9	Bag	20	7-Misc.
10	Filter media	15	2-TecPlastics
11	Filter cover	30	1-BlkPlastics
12	Mains lead	650	1-BlkPlastics
13	Plug top	36	2-TecPlastics
14	Motor	637	3-Ferro
15	Motor part 2	213	4-Non-ferro
16	Fan	27	4-Non-ferro
17	Fan housing	66	3-Ferro
18	Fan washer	5	4-Non-ferro
19	Fan fixing nut	2	3-Ferro
20	Motor mounting	40	2-TecPlastics
21	Internal wiring	35	4-Non-ferro
22	Connectors	4	4-Non-ferro
23	on/off switch	12	4-Non-ferro
24	exhaust filter	15	7-Misc.
25	screws	30	3-Ferro
26	Base chassis	450	1-BlkPlastics
27	Rear wheels	80	1-BlkPlastics
28	Rear wheel axles	40	3-Ferro
29	Front wheels	13	1-BlkPlastics
30	Front wheels axles	35	3-Ferro
31	Internal duct	60	1-BlkPlastics
32	Agitator cylinder	50	1-BlkPlastics
33	Agitator bristle	30	2-TecPlastics
34	Agitator bearing	20	4-Non-ferro

Nr	Component	Weight in g	Material category
35	Agitator drive belt	7	2-TecPlastics
36	Base top cover	180	1-BlkPlastics
37	Nozzle plate	75	1-BlkPlastics
38	Agitator motor	250	3-Ferro
39	Packaging	600	7-Misc.
40	Internal packaging	250	1-BlkPlastics
41	Polybag	20	1-BlkPlastics
42	**Manuals and paper work**	50	**7-Misc.**

Table 11 - Averaged Materials Compositions of Various Vacuum Cleaner Types

		Domestic Canister	Commercial Canister	Domestic Upright	Commercial Upright	Battery / Cordless
Materials	**unit**					
Bulk Plastics	g	4188	5880	3927	4995	3035
TecPlastics	g	695	0	894	1494	426
Ferro	g	1467	1450	1048	1308	1120
Non-ferro	g	478	2250	440	711	1428
Coating	g	8	0	0	0	0
Electronics	g	29	0	0	20	0
Misc.	g	1612	1585	1626	2065	824
Total weight	g	8475	11165	7934	10593	6832

Note1: Batteries and chargers have been included in the battery/cordless vacuum cleaner compositions.

Note2: The average total weight for Battery/Cordless types may have been skewed by one device that was over 11 kg in weight. Typical battery cleaners tend to be 1 to 2 kg.

Material	Domestic Canister	Commercial Canister	Domestic Upright	Commercial Upright	Battery / Cordless
Plastics	56.82%	52.66%	55.61%	59.89%	50.70%
Ferrous metal	16.53%	17.02%	11.67%	15.43%	19.71%
Non-Ferrous metal	6.36%	16.12%	8.14%	3.81%	18.47%
Cardboard/Paper	18.69%	14.20%	22.66%	19.49%	9.95%
Glass	0.25%	0%	0.74%	0%	0.32%
Other	1.35%	0%	1.18%	1.37%	0.84%
TOTAL	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Cardboard/Paper content refers to the packaging materials used and instruction manuals respectively.

4.2 Distribution Phase

Examination of the Bills of Materials (BoMs) indicates that the packaging for vacuum cleaner products is predominantly cardboard material along with smaller amounts of plastics (e.g. LDPE bags).

The average volume of the packaged products for each vacuum cleaner type is considered in the analysis of the Base Case models and BAT.

4.3 Use Phase (product)

The purpose of this section is to identify the resource consumption associated with a vacuum cleaner's use throughout its lifetime.

For vacuum cleaners, the main resource consumed during life is electricity. In addition, filters have to be replaced at regular intervals, (where applicable) dust bags require replacement when filled and, occasionally items such as replacement drive belts are required when products need repairing. The typical replacement frequency of filters, dust bags and replacement drive belts have been estimated in Task 3. These were: a) one set of filters per cleaner per year, b) 10 bags per year for each bagged domestic cleaner, and c) one replacement belt per upright in its lifetime.

4.4 Use Phase (system)

In principle, most of the system parameters relating to vacuum cleaners in use are those mentioned in Section 3.1 on real-life usage. In addition, a vacuum cleaner will interface with the surfaces and materials it comes into working contact with. Alternative routes to fulfil the same or a similar function exist in some cases. For example, it is possible to manually sweep a hard floor surface, but this may introduce other unwanted side effects such as increasing airborne dust.

The vacuum cleaner also interfaces in unwelcome ways with consumers and others in close proximity – it emits noise and particulate matter, both of which could be deleterious to health. The eco-label criteria for vacuum cleaners (now expired) included criteria for noise and dust emissions - <76 dBA and $<0.01\ mg/m^2$ respectively. Vacuum cleaners exhibiting this performance can be considered as best performing is these respects.

At a high level, a vacuum cleaner interacts with its surroundings through the filtered movement of air with functions overlapping with brushing, beating and grooming.

4.5 End-of-life Phase

The Waste Electrical and Electronic Equipment (WEEE) Directive governs the end-of-life (EoL) disposal of vacuum cleaners (VCs). VCs fall under Category 2 (small household appliances) in Annexes IA and IB of this Directive.

Separately collected Category 2 WEEE must have a rate of recovery of at least 70% by an average weight per appliance, and component, material and substance reuse and recycling must achieve at least a 50% rate by an average weight per appliance.

To date, studies on the composition of Category 2 WEEE collections[53] have shown that VCs account for a major proportion (typically around 50% of the total collected). Other appliances (e.g. irons, toasters and kettles) feature at much lower weight % levels (around 5% each). Because EoL VCs are big items, they tend to be taken to central waste collection points rather than disposed with the general household waste. A very small percentage of EoL VCs is reused perhaps involving refurbishment by organisations such as community and charity groups or simply given by their first owners to someone else for example, in their family. In terms of typical materials and component composition, EoL VCs contain significant proportions of plastics. Metal casings and parts have tended to give way to the use of plastics, largely because of cost and flexibility in design.

Our assumptions for EoL phase for vacuum cleaners are as follows:

- All EoL vacuum cleaners are separately collected in accordance with the WEEE Directive
- 70% of separately collected EoL vacuum cleaners are recovered, complying with the WEEE Directive.
- 50% of separately collected EoL vacuum cleaners undergo reuse and recycling, also complying with the WEEE Directive.
- Metals – 95% recycling is assumed (fixed in Eco-Report)
- Plastics – 1% reuse, closed loop recycling assumed. The percentage of material recycling is calculated so that an overall 50% reuse and recycling rate for vacuum cleaners is achieved. The percentage of thermal recycling is such as to achieve an overall recovery rate for vacuum cleaners of 70%.

[53] Study undertaken by AEA in confidence for a client and CIWM/Defra Study on "Trials to Establish WEEE Protocols", Mayer Environmental Ltd., January 2007.

- Landfill – 30% of products are not recovered.

These assumptions represent the minimum level for compliance with the WEEE Directive currently in force.

5 Definition of Base Case

Task 5 involves the development of descriptions of average EU products that can be assumed as “base cases”. The life-cycle characteristics of these base cases are built from the results of Tasks 1 to 4. These base cases will act as the foundation for Task 6 (technical analysis of BAT), Task 7 (improvement potential) and Task 8 (impact analysis).

The base cases have been chosen to be sufficiently broad to cover environmental impacts across the range of vacuum cleaners. Through close collaboration with industry, particularly during the second workshop, we have considered a wide range of actual product cases which has lead to aggregation of product cases into a select few base cases. The five base cases agreed are:

Canister vacuum cleaners – (domestic and commercial types)

Upright vacuum cleaners – (domestic and commercial types)

Battery operated / cordless vacuum cleaners.

This section will describe the modelling of base case models that provide the reference for the environmental and technical/economical improvements to be established further on.

5.1 Product specific inputs

5.1.1 Bill of Materials

The averaged Bill of Materials for each of the 5 base cases are presented in Section 4.1.

The MEEuP EcoReport assumes 1% of the total weight as spare parts. This is considered to be reasonable by the study team.

5.1.2 Primary scrap production during sheet metal manufacturing

The EcoReport default value of 25% has been used.

5.1.3 Volume of packaged product

The average volumes of the packaged products for Domestics Uprights and Canisters have been derived from information provided by stakeholders. Assumptions made for the other base cases are shown in the table below:

Table 12 - Average Volume of Packaged Product

Base Case	Average volume (m^3)	Assumed dimensions of packaged product
Domestic Canister	0.08	-
Commercial Canister	0.1	0.6m x 0.6m x 0.3m
Domestic Upright	0.09	-
Commercial Upright	0.1	0.6m x 0.6m x 0.3m
Battery/cordless	0.05	0.6 m x 0.3m x 0.3m

5.1.4 Use Phase

The inputs for the use phase are:

Table 13 - 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

Note 1 – The total hours in use for canisters and uprights equate to 500 hours (domestic) and 1500 hours (commercial) over the product lifetime.

Note 2 – The electricity consumption for battery/cordless base case has been taken as the overall electricity consumed by the charger. This was considered to be the true electricity consumption for battery/cordless devices because it takes account of total electricity consumed. This total has been calculated from typical charger cycles plus the time spent in standby 'trickle charging' state. Thus, the time that the charger spends in charging mode is taken to represent the annual hours in use. However, whilst the battery/cordless vacuum cleaner is being used, the charger is assumed to be switched off. The detailed calculations used are as follows:

Typical charger is rated as follows:

	Charger Input requirement	Charger Output
Volts	240 v	12 v
Amperes	0.1 A	0.5 A
Power (Watts)	24 W	6 W

Typical charger usage:

a) 15 minutes/week using the battery cordless vacuum cleaner. During this time, the charger is assumed to be switched off)

b) 16 hours/week at full charging rate. (C/10.56[54] – where C is the capacity of the battery),

c) The remaining hours/week, the charger is at trickle-charge rate(C/300):

Table 14 - Annual Power Consumption for a Typical Battery/Cordless Vacuum Cleaner

	Hours per week	Hours per year	Power drawn from mains supply (W)	Annual energy Consumption (kWh)
Hours VC in use per week:	0.25	13	0	0
Hours VC full charging rate per week:	16	832	24	20
Hours VC in trickle-charging rate per week:	151.75	7891	0.8	6.5
TOTAL				**26.5**

5.1.5 Annual Sales 2005 and Stock Model

The following assumptions in Table 15 were used for the 2005 sales and stock (numbers of units) for input in the EcoReport for the Base Case models. A simple Stock Model was created for the calculation of total stock and sales. Stock estimates were derived from population data based on

[54] Assumes the charging efficiency of 66% (this is the best achievable for NiMH batteries)

assumptions made about ownership levels and numbers of households. Sales data gathered in Task 2 were used to derive future sales estimates based on an assumption of an average 3% per year sales growth. Good correlation for estimates of end-of-life arisings was achieved where a lifetime of 8 years was applied to the model.

A ratio of 25:75 was assumed for upright:canister vacuum cleaners.

Table 15 - 2005 Stock and Sales Estimates from Stock Modelling

	% share Canister:Upright	Stock (units)	Annual Sales (units)
Canister domestic	85%	273,595,932	36,543,200
Canister commercial	85%	8,840,000	1,105,000
Upright domestic	15%	48,281,635	6,448,800
Upright commercial	15%	1,560,000	195,000
Battery/cordless	n/a	10,000,000	2,000,000
TOTALS		**342,277,567**	**46,292,000**

5.2 Base Case Environmental Impact Assessment

The summary environmental impacts for the EU stock 2005 is presented in the table below.

Table 16 - Summary 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 tables presented below show the environmental impact per product for each of the Base Case models developed from use of the MEEuP Methodology.

Table 17 - Lifecycle impact (per product) of Canister (Domestic) Vacuum Cleaner

Nr	Life cycle Impact per product:	Date	Author
0	Canister (domestic) Vacuum Cleaners	0	AEA

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			**4334**			1461	2873	**4334**	**0**
2	TecPlastics	g			**695**			234	461	**695**	**0**
3	Ferro	g			**1467**			440	1027	**1467**	**0**
4	Non-ferro	g			**478**			143	334	**478**	**0**
5	Coating	g			**8**			2	5	**8**	**0**
6	Electronics	g			**29**			14	14	**29**	**0**
7	Misc.	g			**1612**			483	1128	**1612**	**0**
	Total weight	g			**8621**			2779	5843	**8621**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	592	219	**811**	**125**	**7965**	297	133	**164**	**9065**
9	of which, electricity (in primary MJ)	MJ	59	129	**188**	**0**	**7881**	0	5	**-5**	**8065**
10	Water (process)	ltr	101	2	**103**	**0**	**631**	0	4	**-4**	**730**
11	Water (cooling)	ltr	573	62	**635**	**0**	**21006**	0	18	**-18**	**21623**
12	Waste, non-haz./ landfill	g	9141	696	**9837**	**87**	**9356**	3174	17	**3156**	**22436**
13	Waste, hazardous/ incinerated	g	86	0	**86**	**2**	**182**	1709	4	**1706**	**1976**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	23	12	**36**	**9**	**349**	22	8	**15**	**408**
15	Ozone Depletion, emissions	mg R-11 ec					negligible				
16	Acidification, emissions	g SO2 eq.	213	53	**266**	**25**	**2043**	45	12	**33**	**2368**
17	Volatile Organic Compounds (VOC)	g	0	0	**0**	**1**	**3**	1	0	**1**	**6**
18	Persistent Organic Pollutants (POP)	ng i-Teq	20	1	**22**	**0**	**52**	22	0	**22**	**96**
19	Heavy Metals	mg Ni eq.	79	3	**82**	**4**	**141**	84	0	**84**	**311**
	PAHs	mg Ni eq.	38	0	**38**	**5**	**21**	0	0	**0**	**64**
20	Particulate Matter (PM, dust)	g	20	8	**28**	**185**	**132**	401	1	**400**	**745**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	64	0	**64**	**0**	**51**	24	1	**23**	**139**
22	Eutrophication	g PO4	4	0	**5**	**0**	**3**	1	0	**1**	**9**
23	Persistent Organic Pollutants (POP)	ng i-Teq					negligible				

Table 18 - Lifecycle impact (per product) of Canister (Commercial) Vacuum Cleaner

Nr	Life cycle Impact per product:							Date	Author		
0	Canister (commercial) Vacuum Cleaners							0	AEA		

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			**5880**			2233	3648	**5880**	**0**
2	TecPlastics	g			**0**			0	0	**0**	**0**
3	Ferro	g			**1450**			435	1015	**1450**	**0**
4	Non-ferro	g			**2250**			675	1575	**2250**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**0**			0	0	**0**	**0**
7	Misc.	g			**1585**			476	1110	**1585**	**0**
	Total weight	g			**11165**			3818	7347	**11165**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	865	275	**1140**	**198**	**17868**	383	149	**233**	**19439**
9	of which, electricity (in primary MJ)	MJ	51	164	**215**	**0**	**17359**	0	2	**-2**	**17572**
10	Water (process)	ltr	95	2	**97**	**0**	**2067**	0	1	**-1**	**2163**
11	Water (cooling)	ltr	645	76	**722**	**0**	**46207**	0	12	**-12**	**46917**
12	Waste, non-haz./ landfill	g	32216	927	**33142**	**122**	**21595**	4108	8	**4100**	**58959**
13	Waste, hazardous/ incinerated	g	45	0	**45**	**2**	**400**	2233	1	**2231**	**2679**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	35	15	**50**	**13**	**788**	29	10	**19**	**870**
15	Ozone Depletion, emissions	mg R-11 ec					negligible				
16	Acidification, emissions	g SO2 eq.	516	66	**582**	**39**	**4573**	57	13	**44**	**5238**
17	Volatile Organic Compounds (VOC)	g	0	0	**0**	**2**	**7**	1	0	**1**	**11**
18	Persistent Organic Pollutants (POP)	ng i-Teq	55	5	**60**	**1**	**114**	28	0	**28**	**204**
19	Heavy Metals	mg Ni eq.	104	12	**116**	**6**	**304**	108	0	**108**	**534**
	PAHs	mg Ni eq.	64	0	**64**	**7**	**40**	0	0	**0**	**111**
20	Particulate Matter (PM, dust)	g	29	10	**39**	**370**	**184**	504	0	**504**	**1097**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	155	0	**155**	**0**	**113**	32	0	**32**	**301**
22	Eutrophication	g PO4	6	0	**6**	**0**	**12**	2	0	**2**	**19**
23	Persistent Organic Pollutants (POP)	ng i-Teq					negligible				

Table 19 - Lifecycle impact (per product) of Upright (Domestic) Vacuum Cleaner

Nr	Life cycle Impact per product:	Date	Author
0	Upright (domestic) Vacuum Cleaners	0	AEA

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			3806			1323	2484	3806	0
2	TecPlastics	g			760			264	496	760	0
3	Ferro	g			1109			333	776	1109	0
4	Non-ferro	g			433			130	303	433	0
5	Coating	g			0			0	0	0	0
6	Electronics	g			25			13	13	25	0
7	Misc.	g			1776			533	1243	1776	0
	Total weight	g			7910			2595	5315	7910	0
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	545	206	750	125	7963	276	133	143	8981
9	of which, electricity (in primary MJ)	MJ	59	122	181	0	7881	0	5	-5	8057
10	Water (process)	ltr	101	2	103	0	628	0	4	-4	727
11	Water (cooling)	ltr	569	58	626	0	21006	0	21	-21	21612
12	Waste, non-haz./ landfill	g	5918	668	6586	87	9321	2912	19	2894	18887
13	Waste, hazardous/ incinerated	g	78	0	78	2	182	1600	4	1596	1858
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	22	11	33	9	349	21	7	13	404
15	Ozone Depletion, emissions	mg R-11 ec				negligible					
16	Acidification, emissions	g SO2 eq.	163	50	213	25	2043	42	12	30	2311
17	Volatile Organic Compounds (VOC)	g	0	0	1	1	3	1	0	1	6
18	Persistent Organic Pollutants (POP)	ng i-Teq	24	2	26	0	52	20	0	20	99
19	Heavy Metals	mg Ni eq.	76	5	81	4	141	78	0	78	304
	PAHs	mg Ni eq.	32	0	32	5	21	0	0	0	57
20	Particulate Matter (PM, dust)	g	19	8	27	185	132	377	1	377	721
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	57	0	57	0	51	23	1	22	130
22	Eutrophication	g PO4	5	0	5	0	2	1	0	1	8
23	Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

Table 20 - Lifecycle impact (per product) of Upright (Commercial) Vacuum Cleaner

Nr	Life cycle Impact per product:	Date	Author
0	Upright (commercial) Vacuum Cleaners	0	AEA

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
	Materials	**unit**									
1	Bulk Plastics	g			**4995**			1631	3364	**4995**	**0**
2	TecPlastics	g			**1494**			488	1006	**1494**	**0**
3	Ferro	g			**1308**			392	916	**1308**	**0**
4	Non-ferro	g			**711**			213	498	**711**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**20**			10	10	**20**	**0**
7	Misc.	g			**2065**			620	1446	**2065**	**0**
	Total weight	g			**10593**			3354	7239	**10593**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	733	297	**1029**	**198**	**17867**	370	172	**197**	**19292**
9	of which, electricity (in primary MJ)	MJ	92	176	**268**	**0**	**17359**	0	6	**-6**	**17621**
10	Water (process)	ltr	110	3	**113**	**0**	**2068**	0	5	**-5**	**2176**
11	Water (cooling)	ltr	731	83	**814**	**0**	**46208**	0	29	**-29**	**46993**
12	Waste, non-haz./ landfill	g	6398	978	**7376**	**122**	**21337**	3901	24	**3877**	**32712**
13	Waste, hazardous/ incinerated	g	79	0	**79**	**2**	**401**	2129	5	**2125**	**2607**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	32	17	**49**	**13**	**788**	28	9	**19**	**868**
15	Ozone Depletion, emissions	mg R-11 eq	negligible								
16	Acidification, emissions	g SO2 eq.	185	72	**257**	**39**	**4570**	56	14	**42**	**4907**
17	Volatile Organic Compounds (VOC)	g	0	0	**1**	**2**	**7**	1	0	**1**	**11**
18	Persistent Organic Pollutants (POP)	ng i-Teq	46	4	**50**	**1**	**114**	27	0	**27**	**192**
19	Heavy Metals	mg Ni eq.	37	10	**46**	**6**	**303**	104	0	**104**	**460**
	PAHs	mg Ni eq.	48	0	**48**	**7**	**40**	0	0	**0**	**95**
20	Particulate Matter (PM, dust)	g	26	11	**37**	**370**	**184**	506	1	**505**	**1097**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	88	0	**88**	**0**	**113**	30	1	**29**	**230**
22	Eutrophication	g PO4	6	0	**6**	**0**	**12**	2	0	**2**	**19**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

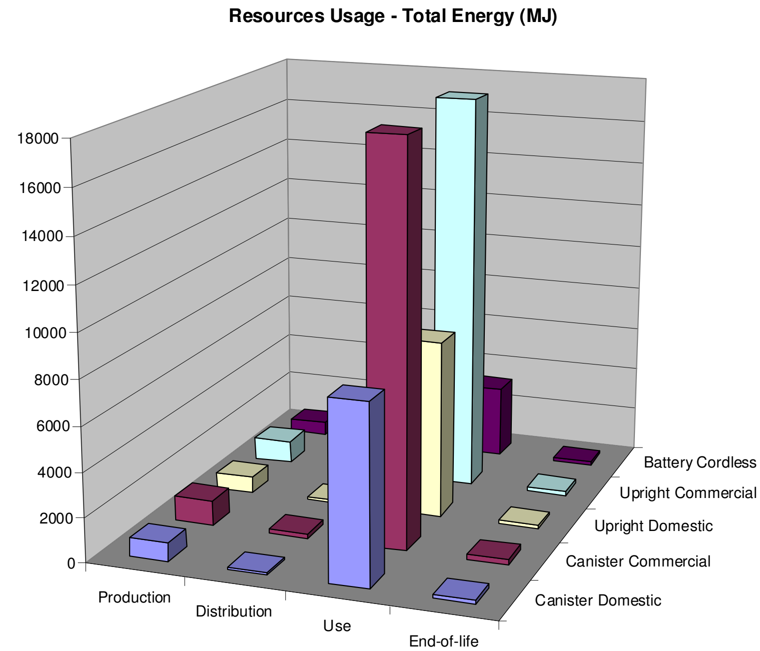
Table 21 - Lifecycle impact (per product) of Battery/Cordless Vacuum Cleaner

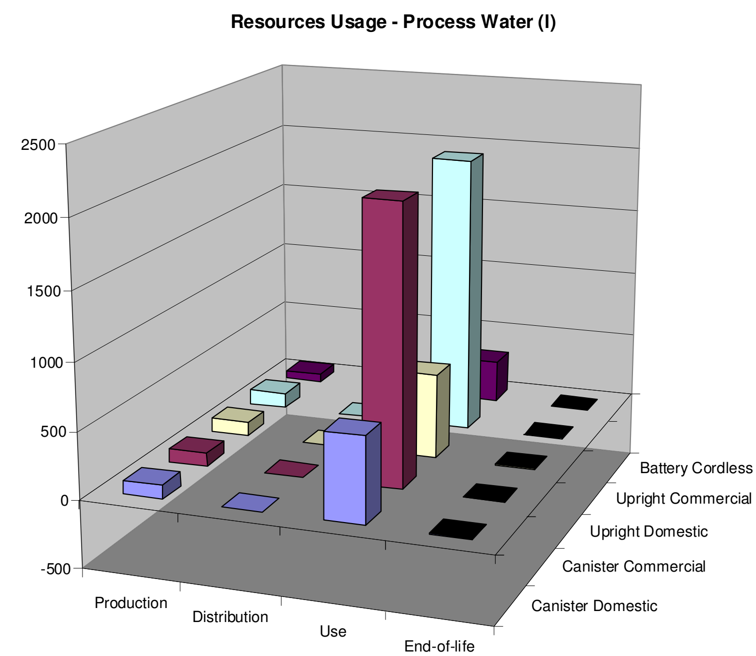
Nr	Life cycle Impact per product:	Date	Author
0	Battery/Cordless Vacuum Cleaners	0	AEA

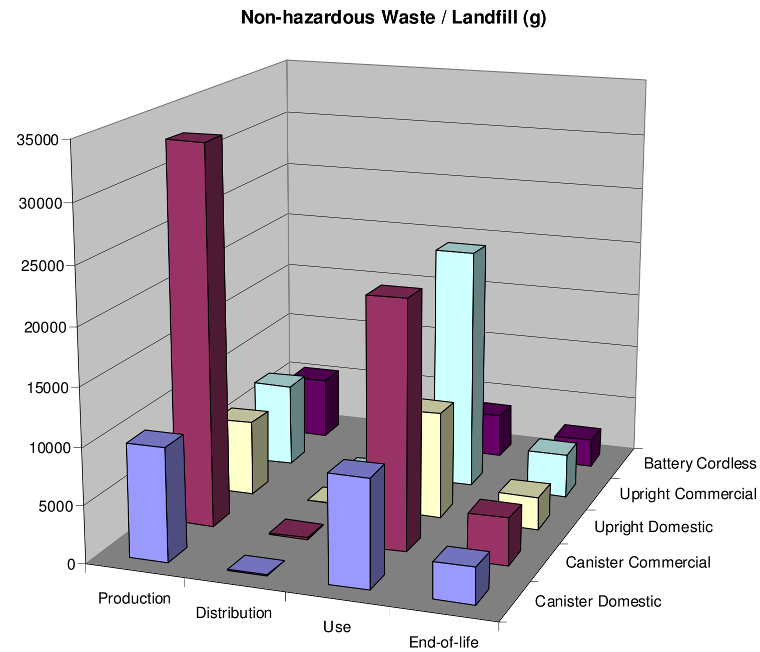
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			**3035**			1198	1837	**3035**	**0**
2	TecPlastics	g			**426**			168	258	**426**	**0**
3	Ferro	g			**1120**			336	784	**1120**	**0**
4	Non-ferro	g			**1428**			428	999	**1428**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**0**			0	0	**0**	**0**
7	Misc.	g			**824**			247	577	**824**	**0**
	Total weight	g			**6832**			2377	4455	**6832**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	423	165	**588**	**125**	**3256**	233	80	**154**	**4122**
9	of which, electricity (in primary MJ)	MJ	33	99	**132**	**0**	**3174**	0	1	**-1**	**3306**
10	Water (process)	ltr	59	1	**60**	**0**	**317**	0	1	**-1**	**376**
11	Water (cooling)	ltr	446	46	**492**	**0**	**8454**	0	5	**-5**	**8942**
12	Waste, non-haz./ landfill	g	4919	556	**5475**	**87**	**3856**	2514	3	**2510**	**11927**
13	Waste, hazardous/ incinerated	g	30	0	**30**	**2**	**73**	1366	1	**1366**	**1470**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	18	9	**27**	**9**	**143**	17	5	**12**	**191**
15	Ozone Depletion, emissions	mg R-11 ec				negligible					
16	Acidification, emissions	g SO2 eq.	96	40	**136**	**25**	**830**	35	7	**28**	**1019**
17	Volatile Organic Compounds (VOC)	g	0	0	**0**	**1**	**2**	1	0	**1**	**4**
18	Persistent Organic Pollutants (POP)	ng i-Teq	96	3	**99**	**0**	**22**	17	0	**17**	**138**
19	Heavy Metals	mg Ni eq.	66	7	**73**	**4**	**60**	66	0	**66**	**203**
	PAHs	mg Ni eq.	20	0	**20**	**5**	**12**	0	0	**0**	**37**
20	Particulate Matter (PM, dust)	g	15	6	**21**	**185**	**106**	305	0	**304**	**617**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	40	0	**40**	**0**	**21**	19	0	**19**	**81**
22	Eutrophication	g PO4	3	0	**3**	**0**	**3**	1	0	**1**	**6**
23	Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

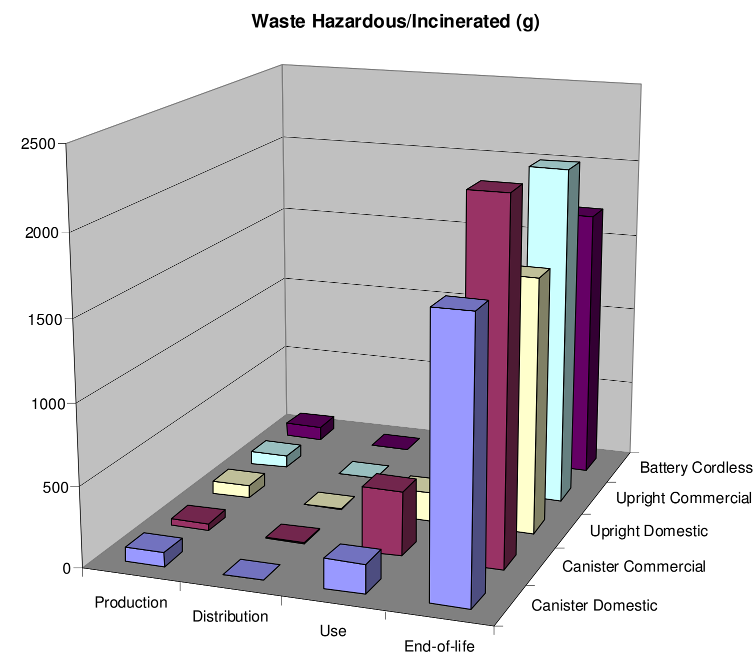
Note: batteries and chargers have been included in the assessment.

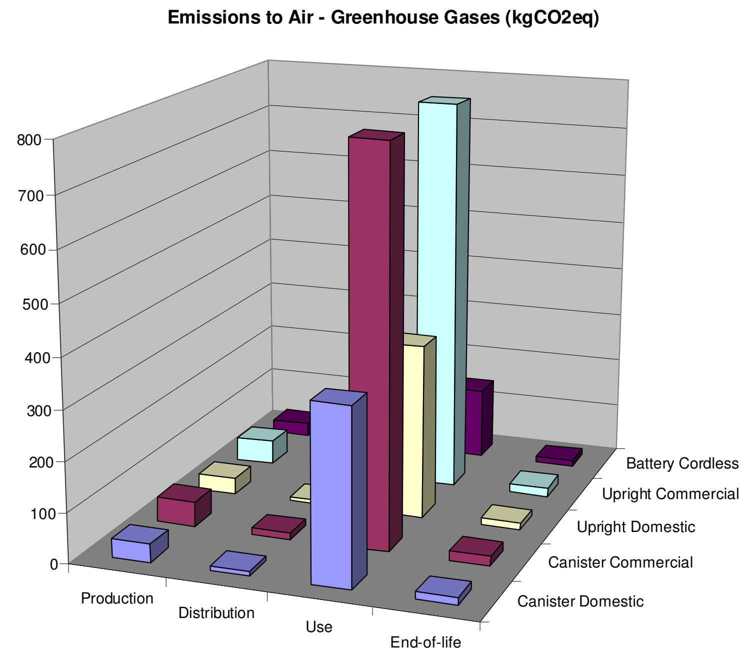
The impacts per product given in the above tables are illustrated graphically below and plotted by Base Case type and life-cycle phase where the impacts occur for each impact category.

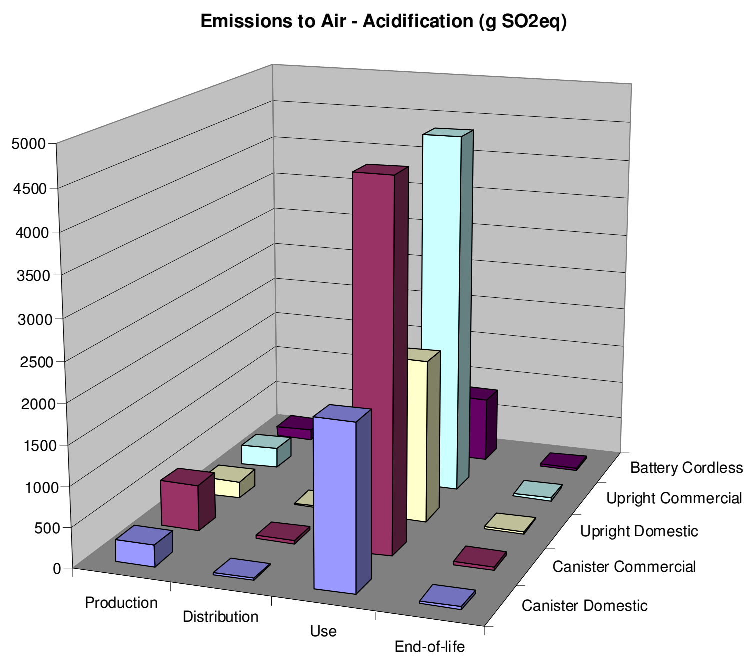


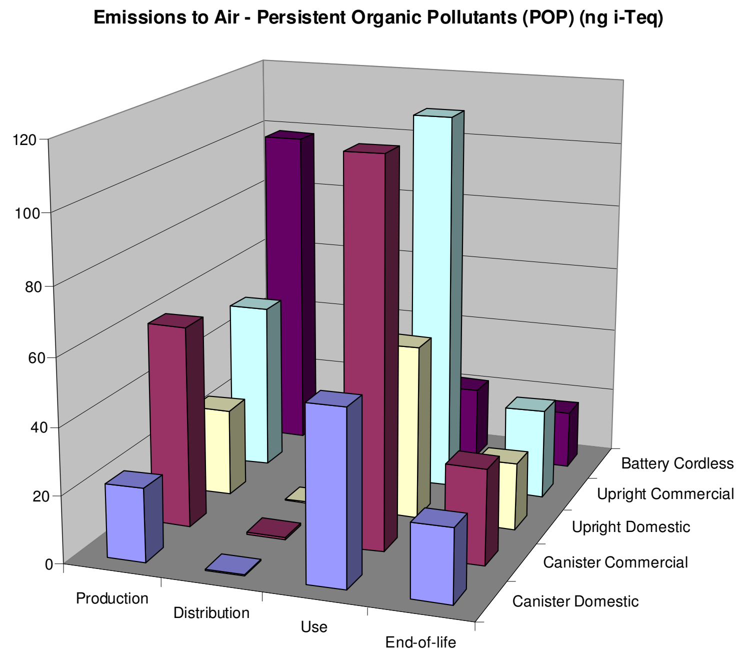


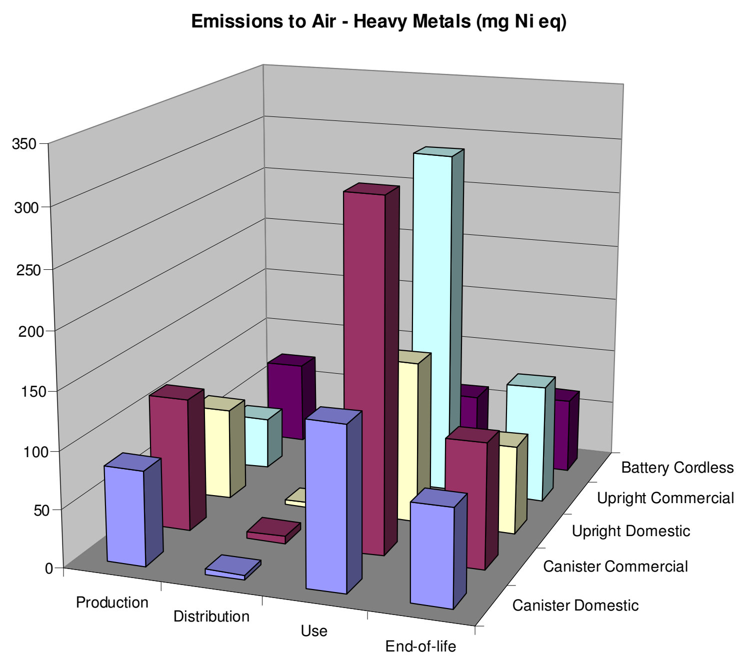

Non-hazardous Waste / Landfill (g)
35000
30000
25000
20000
15000
10000
5000
0
Production
Distribution
Use
End-of-life
Battery Cordless
Upright Commercial
Upright Domestic
Canister Commercial
Canister Domestic


Waste Hazardous/Incinerated (g)
2500
2000
1500
1000
500
0
Production
Distribution
Use
End-of-life
Battery Cordless
Upright Commercial
Upright Domestic
Canister Commercial
Canister Domestic

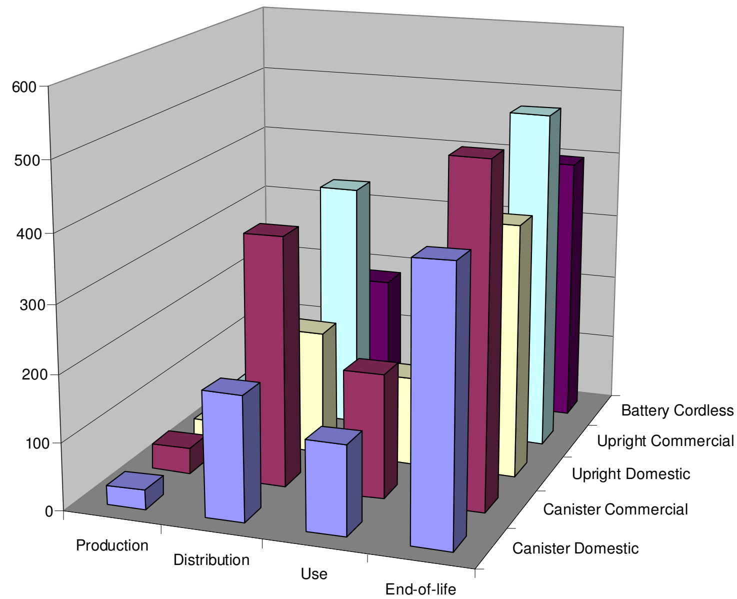

Emissions to Air - Greenhouse Gases (kgCO2eq)
800
700
600
500
400
300
200
100
0
Production
Distribution
Use
End-of-life
Battery Cordless
Upright Commercial
Upright Domestic
Canister Commercial
Canister Domestic


Emissions to Air - Acidification (g SO2eq)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Production
Distribution
Use
End-of-life
Battery Cordless
Upright Commercial
Upright Domestic
Canister Commercial
Canister Domestic

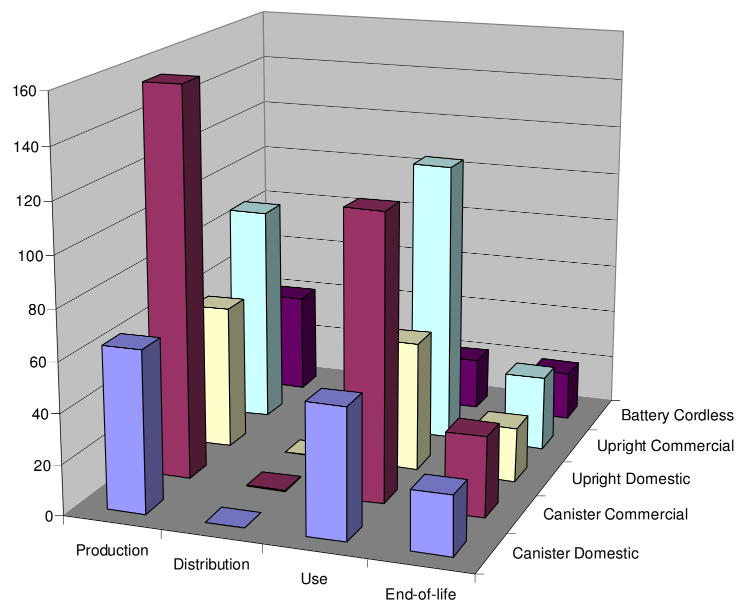

Emissions to Air - Persistent Organic Pollutants (POP) (ng i-Teq)
120
100
80
60
40
20
0
Production
Distribution
Use
End-of-life
Battery Cordless
Upright Commercial
Upright Domestic
Canister Commercial
Canister Domestic

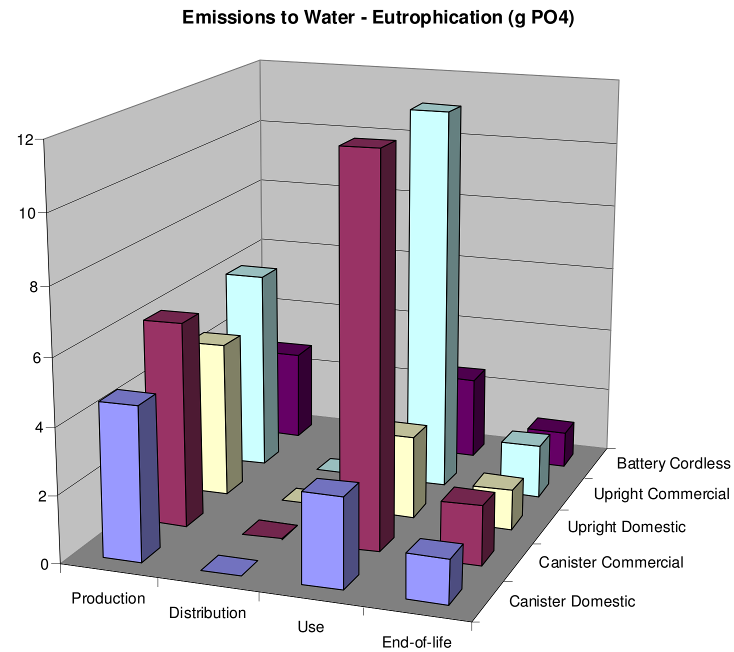

Emissions to Air - Heavy Metals (mg Ni eq)
350
300
250
200
150
100
50
0
Production
Distribution
Use
End-of-life
Battery Cordless
Upright Commercial
Upright Domestic
Canister Commercial
Canister Domestic

Emissions to Air - Particulate Matter (g)



Emissions to Water - Heavy Metals (mg Hg/20)





It should be noted that, in many of the impact categories, the use-phase clearly has the most impact, dominating the life-cycle impact of the product. This is particularly the case for Total energy and process water resources consumed, greenhouse gas and acidification emissions to air.

Table 22 - Percentage of Use Phase Impact of Base Cases

	Canister Domestic	Canister Commercial	Upright Domestic	Upright Commercial	Battery / cordless
Other Resources & Waste					
Total Energy (GER)	87.9%	91.9%	88.7%	92.6%	79.0%
of which, electricity (in primary MJ)	97.7%	98.8%	97.8%	98.5%	96.0%
Water (process)	86.4%	95.6%	86.3%	95.0%	84.2%
Water (cooling)	97.1%	98.5%	97.2%	98.3%	94.5%
Waste, non-haz./ landfill	41.7%	36.6%	49.4%	65.2%	32.3%
Waste, hazardous/ incinerated	9.2%	14.9%	9.8%	15.4%	5.0%
Emissions (Air)					
Greenhouse Gases in GWP100	85.5%	90.5%	86.2%	90.7%	75.1%
Ozone Depletion, emissions	n/a	n/a	n/a	n/a	n/a
Acidification, emissions	86.3%	87.3%	88.4%	93.1%	81.5%
Volatile Organic Compounds (VOC)	56.7%	63.9%	56.8%	63.3%	43.6%
Persistent Organic Pollutants (POP)	54.0%	56.2%	52.5%	59.4%	15.8%
Heavy Metals	45.4%	56.9%	46.4%	66.0%	29.7%
PAHs	32.9%	36.0%	36.7%	41.9%	31.7%
Particulate Matter (PM, dust)	17.7%	16.8%	18.3%	16.8%	17.2%
Emissions (Water)					
Heavy Metals	37.0%	37.8%	39.4%	49.0%	25.9%
Eutrophication	31.3%	59.5%	29.6%	60.2%	39.6%
Persistent Organic Pollutants (POP)	n/a	n/a	n/a	n/a	n/a

5.3 Base Case Life Cycle Costs

The lifecycle costs of the Base Case models are presented in the table below. A typical lifespan of 8 years has been used in the calculations. In all the presented LCC analysis, the total consumed energy, electricity rate of 0.15 euro/kWh, vacuum cleaner bags and filter costs both costed at 10 euro/kg and a discount rate (interest minus inflation) of 5% have been used. Note also: the analysis has assumed all vacuum cleaners are of the disposable bag type. Bagless vacuum cleaners avoid the life cycle costs for bags consumed during the life cycle of the product.

Table 23 - Base Case Life Cycle Costs per Product

	Canister / Upright Domestic	Canister / Upright Commercial	Battery / cordless
Product price	110 €	250 €	110 €
Electricity	91 €	200 €	17 €
Aux. 1: Vacuum cl. bags	52 €	155 €	35 €
Aux. 2 :Office paper (~filters, instruction manuals etc.)	2 €	2 €	2 €
Repair & maintenance costs	8 €	40 €	8 €
Total	**263 €**	**647 €**	**172 €**

Electricity costs are calculated from input power rating, lifetime (years), hours per year usage and the price per kWh for electricity (assumed 0.15 euro/kWh). Costs of vacuum cleaner bags have been calculated from and assumed cost of 10 euros/kg and an assumed bag weight of 100g and 10 bags per year consumption by domestic vacuum cleaners and 30 bags per year for commercial vacuum cleaners.

Note: Although the life cycle cost for the battery/cordless product appears to be cheaper than the mains electricity base cases, this does not suggest that battery/cordless types are better because the hours per week in use differ significantly (i.e. 6 mins/week for battery/cordless cf. 1-3 hours/week for mains vacuum cleaners)

Note: the input value for Overall Improvement Ratio (stock versus New, use phase) has been set at 1.00 in the EcoReport. If anything, the energy consumption of new products is probably higher than the average installed stock. Thus the ratio may be greater than 1.00.

The calculated total annual consumer expenditure (2005) is shown in the table below.

Table 24 - Total Annual Consumer Expenditure 2005 (Million Euros)

Item	Canister Domestic	Canister Commercial	Upright Domestic	Upright Commercial	Battery Cordless	TOTAL
Product price	4020	276	709	49	220	**5274**
Electricity	3847	273	679	48	40	**4888**
Aux. 1: Vacuum cl. bags	2189	212	386	37	80	**2905**
Aux. 2 :Office paper	96	3	14	0	4	**117**
Repair & maintenance costs	342	55	60	10	20	**487**
Total	**10494**	**820**	**1849**	**145**	**363**	**13671**

5.4 EU Totals

The tables presented in Appendix 1 illustrate the outputs from the EcoReport for the impact of base case models sold in 2005 over their lifetime.

5.5 EU Total System Impact

The tables presented in Appendix 2 illustrate the output from the EcoReport for the EU impact of base case models (produced, in use and discarded).

6 Technical Analysis BAT

6.1 State-of-the-Art in Applied Research for the Product

[To be completed in the later stages of the study]

6.2 State-of-the-Art at Component Level

[To be completed in the later stages of the study]

6.3 State-of-the-Art of Best Existing Technology Outside the EU

[To be completed in the later stages of the study]

7 Improvement Potential

7.1 Options

[To be completed in the later stages of the study]

7.2 Impacts

[To be completed in the later stages of the study]

7.3 Costs

[To be completed in the later stages of the study]

7.4 Analysis LLCC and BAT

[To be completed in the later stages of the study]

7.5 Long Term Targets (BNAT) and Systems Analysis

[To be completed in the later stages of the study]

8 Scenario-, Policy-, Impact- and Sensitivity Analysis

8.1 Policy- and Scenario Analysis

[To be completed in the later stages of the study]

8.2 Impact Analysis – Industry and Consumers

[To be completed in the later stages of the study]

8.3 Sensitivity Analysis of the Main Parameters

[To be completed in the later stages of the study]

Appendices

Appendix 1 – EU Impact of Products sold 2005 over their lifetime

Appendix 2 – EU Impact of Products (Total System)

Appendix 1

Table 25 - EU Impact of Domestic Canister VCs sold 2005 over their lifetime

EU Impact of New Models sold 2005 over their lifetime:	Date	Author
Canister (domestic) Vacuum Cleaners	0	AEA

Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
Materials	**unit**									
Bulk Plastics	kt			**140**			47	93	**140**	**0**
TecPlastics	kt			**22**			8	15	**22**	**0**
Ferro	kt			**47**			14	33	**47**	**0**
Non-ferro	kt			**15**			5	11	**15**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**1**			0	0	**1**	**0**
Misc.	kt			**52**			16	36	**52**	**0**
Total weight	kt			**278**			90	188	**278**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	19	7	**26**	**4**	**257**	10	4	**5**	**292**
of which, electricity (in primary PJ)	PJ	2	4	**6**	**0**	**254**	0	0	**0**	**260**
Water (process)	mln. m3	3	0	**3**	**0**	**20**	0	0	**0**	**24**
Water (cooling)	mln. m3	18	2	**20**	**0**	**677**	0	1	**-1**	**697**
Waste, non-haz./ landfill	kt	295	22	**317**	**3**	**302**	102	1	**102**	**723**
Waste, hazardous/ incinerated	kt	3	0	**3**	**0**	**6**	55	0	**55**	**64**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	1	0	**1**	**0**	**11**	1	0	**0**	**13**
Ozone Depletion, emissions	t R-11 eq.				negligible					
Acidification, emissions	kt SO2 eq.	7	2	**9**	**1**	**66**	1	0	**1**	**76**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	1	0	**1**	**0**	**2**	1	0	**1**	**3**
Heavy Metals	ton Ni eq.	3	0	**3**	**0**	**5**	3	0	**3**	**10**
PAHs	ton Ni eq.	1	0	**1**	**0**	**1**	0	0	**0**	**2**
Particulate Matter (PM, dust)	kt	1	0	**1**	**6**	**4**	13	0	**13**	**24**
Emissions (Water)										
Heavy Metals	ton Hg/20	2	0	**2**	**0**	**2**	1	0	**1**	**4**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq				negligible					

Table 26 - EU Impact of Commercial Canister VCs sold 2005 over their lifetime

EU Impact of New Models sold 2005 over their lifetime:	Date	Author
Canister (commercial) Vacuum Cleaners	0	AEA

Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
Materials	**unit**									
Bulk Plastics	kt			**6**			2	4	**6**	**0**
TecPlastics	kt			**0**			0	0	**0**	**0**
Ferro	kt			**1**			0	1	**1**	**0**
Non-ferro	kt			**2**			1	2	**2**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**0**			0	0	**0**	**0**
Misc.	kt			**2**			0	1	**2**	**0**
Total weight	kt			**11**			4	7	**11**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	1	0	**1**	**0**	**17**	0	0	**0**	**19**
of which, electricity (in primary PJ)	PJ	0	0	**0**	**0**	**17**	0	0	**0**	**17**
Water (process)	mln. m3	0	0	**0**	**0**	**2**	0	0	**0**	**2**
Water (cooling)	mln. m3	1	0	**1**	**0**	**45**	0	0	**0**	**46**
Waste, non-haz./ landfill	kt	31	1	**32**	**0**	**21**	4	0	**4**	**57**
Waste, hazardous/ incinerated	kt	0	0	**0**	**0**	**0**	2	0	**2**	**3**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**1**	0	0	**0**	**1**
Ozone Depletion, emissions	t R-11 eq.					negligible				
Acidification, emissions	kt SO2 eq.	1	0	**1**	**0**	**4**	0	0	**0**	**5**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**1**
PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**1**
Emissions (Water)										
Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq					negligible				

Table 27 - EU Impact of Domestic Upright VCs sold 2005 over their lifetime

EU Impact of New Models sold 2005 over their lifetime:	Date	Author
Upright (domestic) Vacuum Cleaners	0	AEA

Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
Materials	**unit**									
Bulk Plastics	kt			**41**			14	27	**41**	**0**
TecPlastics	kt			**8**			3	5	**8**	**0**
Ferro	kt			**12**			4	8	**12**	**0**
Non-ferro	kt			**5**			1	3	**5**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**0**			0	0	**0**	**0**
Misc.	kt			**19**			6	13	**19**	**0**
Total weight	kt			**85**			28	57	**85**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	6	2	**8**	**1**	**86**	3	1	**2**	**97**
of which, electricity (in primary PJ)	PJ	1	1	**2**	**0**	**85**	0	0	**0**	**87**
Water (process)	mln. m3	1	0	**1**	**0**	**7**	0	0	**0**	**8**
Water (cooling)	mln. m3	6	1	**7**	**0**	**226**	0	0	**0**	**232**
Waste, non-haz./ landfill	kt	64	7	**71**	**1**	**100**	31	0	**31**	**203**
Waste, hazardous/ incinerated	kt	1	0	**1**	**0**	**2**	17	0	**17**	**20**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**4**	0	0	**0**	**4**
Ozone Depletion, emissions	t R-11 eq.	negligible								
Acidification, emissions	kt SO2 eq.	2	1	**2**	**0**	**22**	0	0	**0**	**25**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**1**	0	0	**0**	**1**
Heavy Metals	ton Ni eq.	1	0	**1**	**0**	**2**	1	0	**1**	**3**
PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**1**
Particulate Matter (PM, dust)	kt	0	0	**0**	**2**	**1**	4	0	**4**	**8**
Emissions (Water)										
Heavy Metals	ton Hg/20	1	0	**1**	**0**	**1**	0	0	**0**	**1**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	negligible								

Table 28 - EU Impact of Commercial Upright VCs sold 2005 over their lifetime

EU Impact of New Models sold 2005 over their lifetime:							Date	Author		
Upright (commercial) Vacuum Cleaners							0	AEA		
Life Cycle phases -->		**PRODUCTION**			**DISTRI-**	**USE**	**END-OF-LIFE***			**TOTAL**
Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
Materials	**unit**									
Bulk Plastics	kt			**2**			1	1	**2**	**0**
TecPlastics	kt			**0**			0	0	**0**	**0**
Ferro	kt			**0**			0	0	**0**	**0**
Non-ferro	kt			**0**			0	0	**0**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**0**			0	0	**0**	**0**
Misc.	kt			**1**			0	0	**1**	**0**
Total weight	kt			**3**			1	2	**3**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	0	0	**0**	**0**	**6**	0	0	**0**	**6**
of which, electricity (in primary PJ)	PJ	0	0	**0**	**0**	**6**	0	0	**0**	**6**
Water (process)	mln. m3	0	0	**0**	**0**	**1**	0	0	**0**	**1**
Water (cooling)	mln. m3	0	0	**0**	**0**	**15**	0	0	**0**	**15**
Waste, non-haz./ landfill	kt	2	0	**2**	**0**	**7**	1	0	**1**	**11**
Waste, hazardous/ incinerated	kt	0	0	**0**	**0**	**0**	1	0	**1**	**1**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Ozone Depletion, emissions	t R-11 eq.	negligible								
Acidification, emissions	kt SO2 eq.	0	0	**0**	**0**	**1**	0	0	**0**	**2**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Emissions (Water)										
Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	negligible								

Table 29 - EU Impact of Battery/Cordless VCs sold 2005 over their lifetime

EU Impact of New Models sold 2005 over their lifetime:							Date	Author		
Battery/Cordless Vacuum Cleaners							0	AEA		
Life Cycle phases -->		**PRODUCTION**			**DISTRI-**	**USE**	**END-OF-LIFE***			**TOTAL**
Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
Materials	**unit**									
Bulk Plastics	kt			**6**			2	4	**6**	**0**
TecPlastics	kt			**1**			0	1	**1**	**0**
Ferro	kt			**2**			1	2	**2**	**0**
Non-ferro	kt			**3**			1	2	**3**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**0**			0	0	**0**	**0**
Misc.	kt			**2**			0	1	**2**	**0**
Total weight	kt			**14**			5	9	**14**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	1	0	**1**	**0**	**7**	0	0	**0**	**8**
of which, electricity (in primary PJ)	PJ	0	0	**0**	**0**	**6**	0	0	**0**	**7**
Water (process)	mln. m3	0	0	**0**	**0**	**1**	0	0	**0**	**1**
Water (cooling)	mln. m3	1	0	**1**	**0**	**17**	0	0	**0**	**18**
Waste, non-haz./ landfill	kt	10	1	**11**	**0**	**8**	5	0	**5**	**24**
Waste, hazardous/ incinerated	kt	0	0	**0**	**0**	**0**	3	0	**3**	**3**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Ozone Depletion, emissions	t R-11 eq.	negligible								
Acidification, emissions	kt SO2 eq.	0	0	**0**	**0**	**2**	0	0	**0**	**2**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	1	0	**1**	**1**
Emissions (Water)										
Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	negligible								

Appendix 2

Table 30 - EU Impact of Domestic Canister VCs (Total System)

EU Impact of Products in 2005 (produced, in use, discarded)***	Date	Author
Canister (domestic) Vacuum Cleaners	0	AEA

Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
Materials	**unit**									
Bulk Plastics	kt			**140**			47	93	**140**	**0**
TecPlastics	kt			**22**			8	15	**22**	**0**
Ferro	kt			**47**			14	33	**47**	**0**
Non-ferro	kt			**15**			5	11	**15**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**1**			0	0	**1**	**0**
Misc.	kt			**52**			16	36	**52**	**0**
Total weight	kt			**278**			90	188	**278**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	19	7	**26**	**4**	**236**	10	4	**5**	**271**
of which, electricity (in primary PJ)	PJ	2	4	**6**	**0**	**233**	0	0	**0**	**239**
Water (process)	mln. m3	3	0	**3**	**0**	**19**	0	0	**0**	**22**
Water (cooling)	mln. m3	18	2	**20**	**0**	**622**	0	1	**-1**	**642**
Waste, non-haz./ landfill	kt	295	22	**317**	**3**	**277**	102	1	**102**	**699**
Waste, hazardous/ incinerated	kt	3	0	**3**	**0**	**5**	55	0	**55**	**63**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	1	0	**1**	**0**	**10**	1	0	**0**	**12**
Ozone Depletion, emissions	t R-11 eq.	negligible								
Acidification, emissions	kt SO2 eq.	7	2	**9**	**1**	**61**	1	0	**1**	**71**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	1	0	**1**	**0**	**2**	1	0	**1**	**3**
Heavy Metals	ton Ni eq.	3	0	**3**	**0**	**4**	3	0	**3**	**10**
PAHs	ton Ni eq.	1	0	**1**	**0**	**1**	0	0	**0**	**2**
Particulate Matter (PM, dust)	kt	1	0	**1**	**6**	**4**	13	0	**13**	**24**
Emissions (Water)										
Heavy Metals	ton Hg/20	2	0	**2**	**0**	**2**	1	0	**1**	**4**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	negligible								

Table 31 - EU Impact of Commercial Canister VCs (Total System)

EU Impact of Products in 2005 (produced, in use, discarded)*	Date	Author
Canister (commercial) Vacuum Cleaners	0	AEA

Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
Materials	**unit**									
Bulk Plastics	kt			**6**			2	4	**6**	**0**
TecPlastics	kt			**0**			0	0	**0**	**0**
Ferro	kt			**1**			0	1	**1**	**0**
Non-ferro	kt			**2**			1	2	**2**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**0**			0	0	**0**	**0**
Misc.	kt			**2**			0	1	**2**	**0**
Total weight	kt			**11**			4	7	**11**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	1	0	**1**	**0**	**17**	0	0	**0**	**19**
of which, electricity (in primary PJ)	PJ	0	0	**0**	**0**	**17**	0	0	**0**	**17**
Water (process)	mln. m3	0	0	**0**	**0**	**2**	0	0	**0**	**2**
Water (cooling)	mln. m3	1	0	**1**	**0**	**45**	0	0	**0**	**46**
Waste, non-haz./ landfill	kt	31	1	**32**	**0**	**21**	4	0	**4**	**57**
Waste, hazardous/ incinerated	kt	0	0	**0**	**0**	**0**	2	0	**2**	**3**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**1**	0	0	**0**	**1**
Ozone Depletion, emissions	t R-11 eq.	negligible								
Acidification, emissions	kt SO2 eq.	1	0	**1**	**0**	**4**	0	0	**0**	**5**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**1**
PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**1**
Emissions (Water)										
Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	negligible								

Table 32 - EU Impact of Domestic Upright VCs (Total System)

EU Impact of Products in 2005 (produced, in use, discarded)*	Date	Author
Upright (domestic) Vacuum Cleaners	0	AEA

Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
Materials	**unit**									
Bulk Plastics	kt			**41**			14	27	**41**	**0**
TecPlastics	kt			**8**			3	5	**8**	**0**
Ferro	kt			**12**			4	8	**12**	**0**
Non-ferro	kt			**5**			1	3	**5**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**0**			0	0	**0**	**0**
Misc.	kt			**19**			6	13	**19**	**0**
Total weight	kt			**85**			28	57	**85**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	6	2	**8**	**1**	**79**	3	1	**2**	**90**
of which, electricity (in primary PJ)	PJ	1	1	**2**	**0**	**78**	0	0	**0**	**80**
Water (process)	mln. m3	1	0	**1**	**0**	**6**	0	0	**0**	**7**
Water (cooling)	mln. m3	6	1	**7**	**0**	**207**	0	0	**0**	**214**
Waste, non-haz./ landfill	kt	64	7	**71**	**1**	**92**	31	0	**31**	**195**
Waste, hazardous/ incinerated	kt	1	0	**1**	**0**	**2**	17	0	**17**	**20**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**3**	0	0	**0**	**4**
Ozone Depletion, emissions	t R-11 eq.				negligible					
Acidification, emissions	kt SO2 eq.	2	1	**2**	**0**	**20**	0	0	**0**	**23**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**1**	0	0	**0**	**1**
Heavy Metals	ton Ni eq.	1	0	**1**	**0**	**1**	1	0	**1**	**3**
PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**1**
Particulate Matter (PM, dust)	kt	0	0	**0**	**2**	**1**	4	0	**4**	**8**
Emissions (Water)										
Heavy Metals	ton Hg/20	1	0	**1**	**0**	**1**	0	0	**0**	**1**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq				negligible					

Table 33 - EU Impact of Commercial Upright VCs (Total System)

EU Impact of Products in 2005 (produced, in use, discarded)* Upright (commercial) Vacuum Cleaners	Date	Author
	0	AEA

Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions		Material	Manuf.	**Total**	**BUTION**		Disposal	Recycl.	**Total**	
Materials	**unit**									
Bulk Plastics	kt			**2**			1	1	**2**	**0**
TecPlastics	kt			**0**			0	0	**0**	**0**
Ferro	kt			**0**			0	0	**0**	**0**
Non-ferro	kt			**0**			0	0	**0**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**0**			0	0	**0**	**0**
Misc.	kt			**1**			0	0	**1**	**0**
Total weight	kt			**3**			1	2	**3**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	0	0	**0**	**0**	**6**	0	0	**0**	**6**
of which, electricity (in primary PJ)	PJ	0	0	**0**	**0**	**6**	0	0	**0**	**6**
Water (process)	mln. m3	0	0	**0**	**0**	**1**	0	0	**0**	**1**
Water (cooling)	mln. m3	0	0	**0**	**0**	**15**	0	0	**0**	**15**
Waste, non-haz./ landfill	kt	2	0	**2**	**0**	**7**	1	0	**1**	**11**
Waste, hazardous/ incinerated	kt	0	0	**0**	**0**	**0**	1	0	**1**	**1**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Ozone Depletion, emissions	t R-11 eq.	negligible								
Acidification, emissions	kt SO2 eq.	0	0	**0**	**0**	**1**	0	0	**0**	**2**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Emissions (Water)										
Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	negligible								

Table 34 - EU Impact of Battery/Cordless VCs (total system)

EU Impact of Products in 2005 (produced, in use, discarded)* Battery/Cordless Vacuum Cleaners**	Date	Author
	0	AEA

Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
Materials	**unit**									
Bulk Plastics	kt			**6**			2	4	**6**	**0**
TecPlastics	kt			**1**			0	1	**1**	**0**
Ferro	kt			**2**			1	2	**2**	**0**
Non-ferro	kt			**3**			1	2	**3**	**0**
Coating	kt			**0**			0	0	**0**	**0**
Electronics	kt			**0**			0	0	**0**	**0**
Misc.	kt			**2**			0	1	**2**	**0**
Total weight	kt			**14**			5	9	**14**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	PJ	1	0	**1**	**0**	**7**	0	0	**0**	**8**
of which, electricity (in primary PJ)	PJ	0	0	**0**	**0**	**6**	0	0	**0**	**7**
Water (process)	mln. m3	0	0	**0**	**0**	**1**	0	0	**0**	**1**
Water (cooling)	mln. m3	1	0	**1**	**0**	**17**	0	0	**0**	**18**
Waste, non-haz./ landfill	kt	10	1	**11**	**0**	**8**	5	0	**5**	**24**
Waste, hazardous/ incinerated	kt	0	0	**0**	**0**	**0**	3	0	**3**	**3**
Emissions (Air)										
Greenhouse Gases in GWP100	mt CO2 eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Ozone Depletion, emissions	t R-11 eq.	negligible								
Acidification, emissions	kt SO2 eq.	0	0	**0**	**0**	**2**	0	0	**0**	**2**
Volatile Organic Compounds (VOC)	kt	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Heavy Metals	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
PAHs	ton Ni eq.	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Particulate Matter (PM, dust)	kt	0	0	**0**	**0**	**0**	1	0	**1**	**1**
Emissions (Water)										
Heavy Metals	ton Hg/20	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Eutrophication	kt PO4	0	0	**0**	**0**	**0**	0	0	**0**	**0**
Persistent Organic Pollutants (POP)	g i-Teq	negligible								

AEA Energy & Environment
From the AEA group
Fermi Avenue
Harwell International Business Centre
Didcot
Oxfordshire
OX11 0QR

Tel: 0845 345 3302
Fax: 0870 190 6138

E-mail: info@aeat.co,uk

www.aea-energy-and-environment.co.uk