Service Contract to DGTREN

Preparatory study on the environmental performance of residential room conditioning appliances (airco and ventilation)

Contract TREN/D1/40-2005/LOT10/S07.56606

Study on comfort fans –final report
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CO-ORDINATOR: Philippe RIVIERE, ARMINES, France

PARTICIPANTS

Jérôme ADNOT, Laurent GRIGNON-MASSE, Sébastien LEGENDRE,
Dominique MARCHIO, Guillaume NERMOND,
Sri RAHIM, Philippe RIVIERE
ARMINES, France

Philippe ANDRE, Laurie DETROUX, Jean LEBRUN, Julien L'HOEST, Vladut TEODOROSE
Université de Liège (ULg), Belgium

José Luis ALEXANDRE, Emanuel SA
IDMEC, University of Porto, Faculty of Eng., Portugal.

Georg BENKE, Thomas BOGNER
Austrian Energy Angency, Austria

Amanda CONROY, Roger HITCHIN, Christine POUT, Wendy THORPE
BRE, UK

Stavroula KARATASOU
IASA, Greece

Note : ventilation fans are treated in another document, this report is about comfort fans.

Legal disclaimer

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 Definition of product, standards and legislation

According to the MEEuP methodology, *this task should define the product category and define the system boundaries of the 'playing field' for ecodesign. It is important for a realistic definition of design options and improvement potential (Task 7) and it is also relevant in the context of technically defining any implementing legislation or voluntary measures (if any) (Task 8).*

1.1 Product category and performance assessment

1.1.1 Product definitions

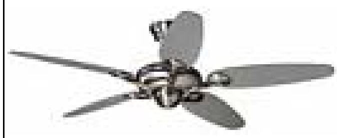
Using fans and moving air in a room is a way people can choose to improve their individual summer comfort. **By generating air movement close to the body, comfort fans increase convection and evaporation and by this way the feeling of comfort.** Thus, using comfort fans improve the individual summer comfort without lowering the room temperature. In fact, the inside temperature is even likely to increase since the comfort fan motor produces heat.
On the other hand, fans should not be used as a primary cooling device during extended periods of excessive heat. Electric fans may provide relief, but when the temperature is above 35 °C, fans will not prevent heat related illness (Adnot, 2007) but on the contrary will contribute to heat exhaustion. Use of summer comfort fans should be guided by an indoor climate stress diagram.

Comfort fans can be used to avoid the use of air conditioners during the summer period and provide an "acceptable comfort", but it can also be used as a complement to this device. When air conditioning is used, a fan can help to better circulate the cool air through the room, allowing the system to run less often[1].

Table 1-1: Different types of comfort fans and their technical characteristics

Type	Typical characteristics	Example
Table fan – Desk fan	Propeller diameter: 250-400 mm Air flow: 1300-3600 m^3/h Electrical supply: 35-60W	 Delhongi
Pedestal fans	Propeller diameter: 250-450 mm Air flow: 2000-4500 m^3/h Electrical supply: 40-70 W	 Alpatec

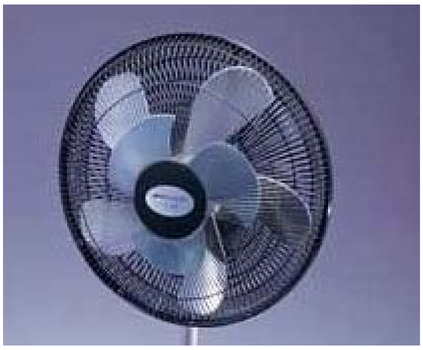
[1] http://www.energystar.gov

Floor standing fans	Propeller diameter: 300-500 mm Air flow: 3000-6000 m^3/h Electrical supply: 40-120W	 Alpatec
Wall mounted fans	Propeller diameter: 250-400 mm Air flow: 1300-3600 m^3/h Electrical supply: 35-60W	
Ceiling fans	Propeller diameter: 900-2000 mm Number of blade: 3-5 Electrical supply: 50-150W (without lights)	 Coolandwarm
Tower fans	Height: 350-1400 mm Air flow: 400-2200 m^3/h Electrical supply: 35-50W	Alpatec 
Box fans	Propeller diameter: 250-400 mm Air flow: not specified Electrical supply: 35-60W Louvers available to orientate the flow	 Rovex

Most fans have various speeds. Part of the fans are oscillating horizontally (if the user demands it) and a few even oscillate vertically.

We have observed the existence of a new type of fan (called “2cool” by Bionaire) with a higher electricity consumption than usual products (90 W) using two “fans”: higher velocity in the center (25 cm), large coverage of sides (40 cm). Hereunder the appearance of that product :

Figure 1-1: “2cool” fan by Bionaire



As soon as there is a remote control, there is a standby consumption. It's infrequent except for ceiling fans and tower fans, and this stand by consumption is never indicated in commercial offers.

In Taiwan there is a so called "autorevolving hanging fan" that we have not observed on the EU market.

1.1.2 Existing product categorisations

The Prodcom categorization clearly distinguishes the comfort fans (NACE 29.71.15.30) from ventilation fans (the extraction ones: NACE 29.23.20.30, NACE 29.23.20.70…). There is **no category for comfort fans with an electrical power higher than 125 W and tower fans are not mentioned**.

Table 1-2: Prodcom segmentation for ventilators

Fans covered by NACE 29.23 ("Manufacture of non-domestic cooling and ventilation equipment")	
29.23.20.30	Axial fans (excluding table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output[2] <= 125 W)
29.23.20.70	Centrifugal fans (excluding table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output[2] <= 125 W)
29.23.20.70	Fans (excluding table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output <= 125 W)
Fans covered by NACE 29.71 ("Manufacture of electric domestic appliances")	
29.71.15.30	Table, floor, wall, window, ceiling or roof fans, with a self contained electric motor of an output[2] <= 125 W
29.71.15.33	Roof ventilators
29.71.15.35	Other ventilators
29.71.15.50	Ventilating or recycling hoods incorporating a fan, with a maximum horizontal side <= 120cm

Technical description of comfort fans is given to specify the content of NACE 29.71.15.30. Testing standard in other economies[3] consider these different types as categories (table fan, wall-mounted fan, floor table fan, floor standard fan and ceiling fan).

The tower fans (whose market share is growing nowadays) are not mentioned explicitly in NACE but may have been considered as table fans. However they are not covered in existing test standards and legislation abroad.

The box fans (whose market share is growing nowadays) are not mentioned but may be considered as table fans. Practically they seem to be covered in existing test standards.

1.1.3 Functional analysis

The primary function of comfort fans is **to increase air speed in such a manner the end user may feel more comfortable**. Since air speed must not be increased too much to get acceptable comfort

[2] from the translations it is clear that the word "output" here is understood as electrical power

[3] See Task 1.2 on test standards in third countries and Task 1.3 Legislation in Third countries.

conditions and that comfort is likely to be increased if the air stream attains a larger part of the body, the functional unit would then be "**to move air inside a room"** and the performance parameter to be kept is the air flow rate supplied by the fan.

Different categories have been identified but do not correspond to secondary functions. The fact that tower fans moves the air in a limited angle does not create a very large functional difference because the fan oscillates at the same time. It can be said roughly that it generates the same primary effect with a lower flow, not that it has a secondary function.

About comfort fans used in the USA, a secondary functionality consists in lighting up a room (ENERGY STAR program). This functionality only concerns ceiling fans that can be associated with a lighting system. This has no direct link with residential room conditioning appliances but changes the environmental impact of the product. Indeed, there are many cases when compatibility is only between light kits and ceiling fans under the same brand. Then some ceiling fans must not be promoted if their associated lighting system is not efficient enough even if the fan is efficient. Both products, comfort fan and lighting kit, may be considered separately.

1.2 Test Standards

This task should (EuP methodology):

Identify and shortly describe

- *the harmonised test standards;*
- *and additional sector-specific directions for product-testing.*

regarding the test procedures for:

- *the primary and secondary functional performance parameters mentioned above;*
- *resources use (energy, water, paper, toner, detergent, etc.) and emissions (NOx, CO, particulate matter) during product-life;*
- *safety (gas, oil, electricity, EMC, stability of the product, etc.);*
- *noise and vibrations (if applicable);*
- *other product specific test procedures.*

Apart from mentioning these standards, including a short description, it should also be reported which new standards are being developed, which problems (e.g. regarding tolerances, etc.) exist and what alternatives are being developed. Furthermore, the (ongoing) work on an ecodesign-standard, mandated by the European Commission to standardisation bodies, should be considered.

1.2.1 Energy use

Performance parameter and energy use

The main testing standard is an IEC standard, not covered by a CENELEC standard.

IEC 60879	Performance and construction of electric circulating fans and regulators.

Here after is reported the scope of the standard.

"This standard applies to the following types of electric motor directly driven fans and their associated regulators intended for use on single-phase a.c. and d.c. circuits not exceeding 250 V:

a) Fans for household and similar purposes:
- ceiling type fans;
- table type fans;
- pedestal fans;

b) Fans for use in ships:
- Deck-head type fans;
- Cabin type fans.

Note: Wherever applicable the term "fan" used in this standard includes its associated regulator, if any.

This standard does not apply to the following types of fans which are covered in separate standards:

- Jet fans (see IEC Publication 535: Jet Fans and Regulators); the detailed study of this testing standard seems to indicate that it is not applicable to tower fans because it uses the axial symmetry; however the standard does not include a clear definition of what is a jet fan;
- Ventilating fans (see IEC Publication 665: A.C. Electric Ventilating Fans and Regulators for Household and Similar Purposes).

This standard does not apply to safety requirements for electric circulating fans and regulators, which are covered by IEC Publication 342: Safety Requirements for Electric Fans and Regulators."

It is interesting to note that tower fans are not explicitly covered. We think the test procedure could apply but we have not obtained any test reports (for the other types either) from the stakeholders so that we doubt that manufacturers in this branch use international testing standards. There are two language versions in IEC and the French version translates strangely pedestal fans by "ventilateurs à colonne", a source of ambiguity with tower fans that may be called like that in French.

The IEC 60879 standard defines an Energy Efficiency Index, called "service value" in English and "indice de qualité" in French, which is of the same nature as an SFP in ventilation : a ratio of the flow generated to the electrical power absorbed. It is an index suitable for the purpose, since there is no pressure difference to be maintained between upstream and downstream, as opposed to ventilation systems where pressure levels matter. It's measured at full speed, which does not seem to generate a big problem in this case. The standard does include the energy needed for the oscillating mechanism in the total electricity demand. The flow is measured without the oscillations, which are reported by some as generating a loss in flow rate as stated in the extract below.

"Service value
The air delivery in cubic meters per minute divided by electrical power input to the fan in watts at the voltage and frequency specified for the test.
In the event of the fan comprising an oscillating mechanism, the electrical input in watts is measured with the fan under normal full-speed conditions, that is with the oscillating mechanism in action, whereas the air delivery is determined with the oscillating mechanism out of action."

This service value (SV) and the "rated air delivery" (flow rate) "shall be supplied on request". Only very few manufacturers really indicate it at the time of sale. An energy labeling system in Europe, if suitable, would reinforce this obligation.

One aspect of the IEC 879 standard is that there are functional requirements and even design values recommended: preferred sizes for ceiling fans, other for table fans, other for pedestal fans, a fact that generates this uniformity of declared characteristics that we observe on the market.

Another interesting aspect of IEC 879 is that it includes a set of tolerances to apply when only one piece of equipment is tested to check the declarations of a manufacturer : 10% on air flow, which, since electrical power is very certain, means about 10% on "service value".

Table 1-3: values for table fans (TABLE I of standard)

Size of fan (mm)	Minimum number Of regulated speeds	Type
200	1	Non-oscillating
250 300 350 400	1 2 3 3	Oscillating or non-oscillating

Table 1-4: values for pedestal fans (TABLE II of standard)

Size of fan (mm)	Minimum number Of regulated speeds	Type
300 400 500 600	2 2 2 2	Oscillating or non-oscillating

Even the oscillations are harmonised :

"The number of oscillations per minute at full speed shall be not less than four.
Whether or not the angular movement of the mechanism is variable, an angular movement of not less than 60 ° shall be available […].
A device shall be provided to render the oscillating mechanism inoperative when desired. The method of operating the device shall be indicated. "

It is the same for the speeds:

"Regulators shall be capable of reducing the speed of the fan by at least 50 % of the full speed at the voltage and frequency specified for the test, except in the case of fans of the shaded pole type where the speed reduction shall be not less than 20 %. Fans shall be capable of running continuously on any of the contacts of the regulator at the rated voltage or voltages or within the whole rated voltage range, whichever is applicable."

The prescription about noise is not that clear:
"The noise level of fans and regulators at all speeds shall be within reasonable limits".

Finally tolerance is fixed on the rated air flow rate at full speed at 10 %. There is no explicit tolerance on the service vale (SFP) of the product, but it can be estimated.

There is no specific test standard in Europe for testing energy use of comfort fans (that could be easily written on the basis of IEC 879 with extension to tower fans).

Chinese and Taiwanese testing standards

Those have a special importance since the regions in question are significant designers and manufacturers. It has been impossible to access the Taiwanese testing standards CNS 2450, 2061, 597 and 547.
A summary of Chinese standard testing standard GB/T 13380-2007 has been generated recently and seems to indicate consistency with IEC 60879-1986, a good basis for consistency of a potential EU MEPS with Mainland China MEPS, the place wherefrom the fans are mostly imported. From the full Chinese version we extract a few interesting lessons : tower fans have been included in the scope;

Chinese MEPS (that will be presented later in the "legislation" section as "label 3") is indeed included in the testing standard; there is also an acoustic maximum impact in dB(A) implemented through the testing standard. For simplicity, we will describe those in the "legislation" section.

Other regional standards

For other economies, the main source of information is the APEC ESIS website.
It is often mentioned that all the test standards listed below are in-line with IEC test standard (with some minor variations).

Table 1-5: International test standards for comfort fans

Country	Type	Test standards
International	Ceiling Pedestal Table	IEC 60879: Performance and construction of electric circulating fans and regulators.
India	Ceiling Pedestal Table	IS 374:1979 IS 1169:1967 IS 555:1979
Sri Lanka	Ceiling	SLS 814:1988
Bangladesh	Ceiling Pedestal Table	BDS 818 BDS 843 BDS 844
Canada	Ceiling	CSA C814-96-1998

Testing procedure for Bangladesh is roughly described on the APEC-ESIS website[4]:

- High voltage test at 1.5 kW
- Insulation resistance test
- Temperature rise test
- Air delivery [m3/min]
- Service value [m3/min/W]
- Electrical input [kW]
- Speed of fan [rpm]

The Nexant study (2003) indicates that the measurement method of the Canadian standard differs substantially from the IEC standard (we can imagine it's related with the US standard), while standards in use in India and Sri Lanka use the same apparatus. It also provides the typical cost of equipment needed to install a test bench under IEC 879, around US$ 8000.

ENERGY STAR Test Standard for Residential Ceiling Fans

In performing these tests, manufacturers must use Hunter's Solid State Test Method. A fan is hung above a tunnel or a large diameter tube in a standard temperature and humidity-controlled room. The air delivered by the fan is made to pass through the tunnel. At the end of the tunnel, a row of velocity sensors is mounted on a rotating arm. The airflow at various points in the tube is measured simultaneously and instantaneously for several seconds. The average reading of air velocities is then used to compute the air delivery by calculations.
The important characteristic of the Solid State Test Method is the use of the latest method of measurement of air velocities by multiple probes. Instead of moving a mechanical or an electronic probe from point to point to measure the airflow (velocity); this method allows to perform simultaneous monitoring of air velocity instantly. The information is recorded in real time and can be

[4] http://www.clasponline.org/teststandard.php?no=137

analyzed as the measurement is being taken. The probes utilize the technology of hot wire anemometer. Each probe has a temperature and cooling rate sensor. The signal from these sensors is fed into the computer via the control box. Using the appropriate software, calculations are made to compute the air delivery of the fan. This multi-point measurement of airflow velocity as well as air surface temperature analysis is a crucial step in the development of this method. The complete test takes under two minutes, not including the time to hang the fan.

1.2.2 Noise

ISO 10302:1996	Acoustics-Method for the measurement of airborne noise emitted by small air-moving devices
EN 60704-2-7	Household and similar electrical appliances – Test code for the determination of airborne acoustical noise (1998). Part 2. This standard describes the determination of the noise emission of household fans in normal operation at maximum speed. This standard applies to table fans, pedestal fans, ceiling fans and partition fans.

We have seen previously that IEC 879 does not really bring a numerical value. The Chinese testing standard brings its own procedure for noise measurement.

1.2.3 Safety

UL 507	Underwriters Laboratories Standard for Safety for Electric Fans Voluntary safety standard for electric fans (1999): ceiling, desk…

The design, construction, installation, testing and use of electrical equipment shall be in accordance with the appropriate European standards, e.g. EN 60335– “household and similar electrical appliances – safety ”.

Mechanical safety problems: in France twice comfort fans models have been withdrawn from the market for mechanical danger. One should look at Rapex system – communication between Member States about unsafe products, toys, home appliances- to know the reasons and frequency. However this is not in the methodology of present study.

1.2.4 Conclusion on test standards

IEC standard covers most of the needs but not all (tower fans not explicitly covered). Inaccessible Chinese standard (the most producing country) claims a link with the international standard. About comfort fans we can imagine an EU implementation of the procedures defined in the testing standard IEC 879, needed for technical reasons and also to generate some EU know how to test those products, which means
- generating an EU standard completely compatible with the existing IEC,
- having at least one lab in Europe,
- indicating applicability to "tower fans" (not explicitly covered in IEC),
- indicating that the control is part of the product, and should be tested at part load, which could lead to some improvements,
- demanding to report not only total flow but also velocities, so as to enable comparison of the tower fans which do not move the air in the whole room as opposed to other types of fans.

1.3 Existing legislation

1.3.1 Legislation and Agreements at European Community level

No effect of environmental directives (RoHS, WEEE, Packaging directive) has been documented by stakeholders.

1.3.2 Legislation at Member State level

No legislation has been indicated yet as being relevant by the Member States.

1.3.3 Third Country Legislation

This section again deals with the subjects as above, but now for legislation and measures in Third Countries (extra- EU). None has been indicated by stakeholders (NGOs , industry, consumers) as being relevant for the product group.

Three main programs do exist for comfort fans, in the USA, in Taiwan and in China, that we will describe now.

1.3.3.1 USA

ENERGY STAR[5] Program for Residential Ceiling Fans (2006)

A residential ceiling fan is defined as a non-portable device designed for home use that is suspended from the ceiling for circulating air via the rotation of fan blades. Some ceiling fans also have an integral or attachable light kit submitted to separated specific requirements including for its lighting function.
To be qualified as Energy Star, ceiling fans must meet several specification criterias regarding air flow efficiency, controls, minimum warranty, consumer information.

Airflow efficiency

Tested representative model (i.e., unit shipped to test facility) must meet the minimum requirements listed below without the assistance of the 5 percent tolerance at the time of testing. Once a representative model has qualified as ENERGY STAR, all additional units manufactured under the same model name/number, and found in the distribution channel (i.e., retail), must perform within 5 percent of the tested performance levels submitted to EPA and listed on the ENERGY STAR Web site.

Table 1-6: ENERGY STAR requirements for ceiling fans

Air flow efficiency requirements					
Fan speed	**Minimum airflow (CFM)**	**Minimum airflow (m^3/h)**	**Efficiency requirements (CFM/W)**	**Efficiency requirements (m3/min/W)**	**Performance ratio [$W/(1000m^3/h)$]**
Low	1,250	736	155	1.52	11.0
Medium	3,000	1766	100	0.98	17.0
High	5,000	2943	75	0.74	22.7

(1 CFM = 1.699 m^3/h)

Controls

5 http://www.energystar.gov

Qualifying products shall permit convenient consumer adjustment of fan speed. This may be accomplished by means of one or more wall-mounted switch(es), a remote control, or pull chains. For those residential ceiling fans that can accommodate light kits, the lights and the fans must be able to be controlled separately, allowing users to switch off lights during fan operation or operate the lights without using the ceiling fan.
Qualifying products shall also provide for consumer adjustment of airflow direction (upward or downward). This may be accomplished by means of a vertically or horizontally mounted slide switch on the motor housing, one or more wall-mounted switch(es), a remote control, or pull chains.

Minimum warranty

Qualifying products shall provide a warranty of at least 30 years for the motor and at least one year for all other components of qualifying residential ceiling fans. All ceiling fan light kits (i.e., integral and sold separately) shall also meet applicable warranty requirements.

Consumer information

In addition to the ENERGY STAR mark, packaging of ENERGY STAR qualified residential ceiling fan models shall also state airflow, fan power consumption, and airflow efficiency at each of their three operating speeds, as determined by the test procedures specified by ENERGY STAR. If the ceiling fan model offers more than three speeds, performance results should be provided for all speeds indicated on the packaging of the product, indicating which three speeds were used to qualify the fan as ENERGY STAR. This information shall appear in the following form on the outside portion of the package:

Table 1-7: Information format to be supplied for ENERGY STAR ceiling fans

Fan Speed	Airflow	Fan Power Consumption (without lights)	Airflow Efficiency (higher is better)
Low	[CFM]	[watts]	[CFM/watt]
Medium	[CFM]	[watts]	[CFM/watt]
High	[CFM]	[watts]	[CFM/watt]

Product operating and installation instructions shall also include a short list of standardized information regarding how to operate the products efficiently. This list shall include, at least, information on:

- How to adjust the fan speed and direction according to the season and to the room occupancy to maximize energy savings,
- HVAC thermostat adjustment for energy savings when a ceiling fan is used,
- Proper mounting distance from the ceiling to maximize efficient operation,
- How to find proper replacement lamps for the light kit, whether included.

Testing and Reporting Procedures

Manufacturers are required to perform tests and self-certify each representative model that they intend to qualify as ENERGY STAR. In performing these tests, laboratories must use the test method described in EPA's *ENERGY STAR Testing Facility Guidance Manual: Building a Testing Facility and Performing the Solid State Test Method for ENERGY STAR Qualified Ceiling Fans*. (EPA: Environmental Protection Agency)

<u>Laboratory Testing</u>
Under this specification, ceiling fans may only be tested by those laboratories that meet the guidelines provided in EPA's ENERGY STAR Testing Facility Guidance Manual and have been approved to test for ENERGY STAR qualification. EPA conduct annual "round-robin" testing of these laboratories

(i.e. calibrations), to verify that test results fall within +/- 5 percent of each other. This process is performed using a reference fan provided by EPA.

Reporting Requirements

The company whose brand name appears on the product packaging shall, for purposes of this specification, be considered the manufacturer. Manufacturers must complete a QPI form when submitting qualified products to EPA. This form must be accompanied by reports from a qualified laboratory containing airflow, power consumption, airflow efficiency data, and lighting test results (where applicable) for each residential ceiling fan model and light kits proposed for qualification. Families of residential ceiling fan models that are identical in every respect but finish may be qualified through submission of test data for a single representative model. Likewise, models that are unchanged or that differ only in finish from those sold in a previous year may remain qualified without the submission of new test data, assuming the specification remains unchanged. However, separate test data are required for all models that differ in any of the following characteristics: motor type or size; rotational speed; control type; blade (weight, number, size, or pitch); housing (i.e., size, design, ventilation).

Product Performance Review Process

To the extent ENERGY STAR is a self-certification program, EPA relies on the integrity of participating companies to ensure all products for which ENERGY STAR claims are made, meet all aspects of the ENERGY STAR performance specification. When mistakes are made and products are mislabeled or fail to perform as expected, EPA is committed to ensuring prompt corrective action, can perform its own tests to check the performance if necessary to comfort its decision to remove the fan from the list of qualified products.

Update of criterias

There is no transition period - called “grand-fathering” to let the opportunity to manufacturers to sell the stock of non compliant models when requirements are increased.

CALIFORNIA Program for Residential Ceiling Fans (2006)

The Appliance Efficiency Regulations, (California Code of Regulations, Title 20, Sections1601 through 1608) dated December 2006, contain amendments that were adopted by the California Energy Commission on July 5, 2006, and October 11, 2006, and approved by the California Office of Administrative Law on December 11, 2006 and December 14, 2006. The Appliance Efficiency Regulations include standards for both federally-regulated appliances and non-federally-regulated appliances. Twenty-one major categories of appliances are included in the scope of these regulations. The standards within these regulations apply to appliances that are sold or offered for sale in California.

Each package containing a ceiling fan whose diameter exceeds 50 inches (127 cm) shall be marked, permanently and legibly on an accessible and conspicuous place on the unit’s packaging, in characters no less than 1/4”, the unit’s airflow at high, medium, and low speed in CFM, and the unit’s air flow efficiency in CFM/watt at high, medium and low speed. This is not very different from the Energy Star requirement, but compulsory in the State.

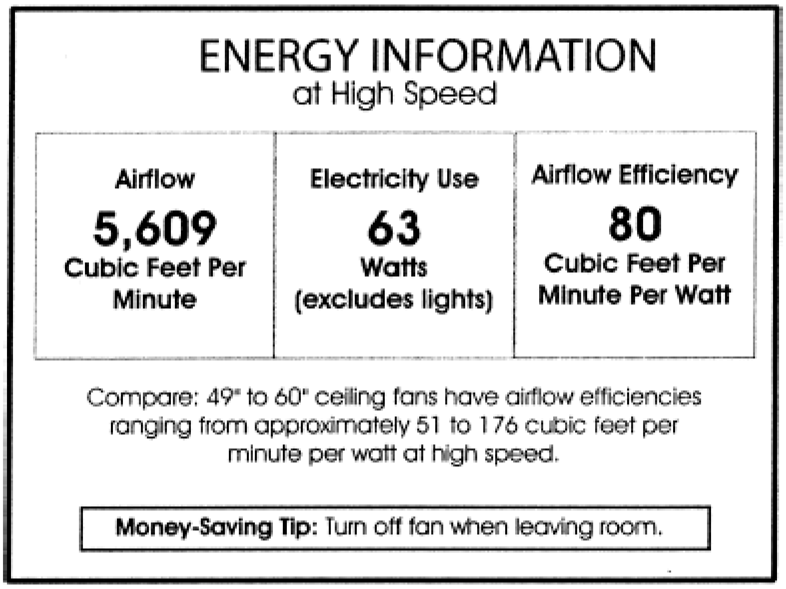
FTC Appliance labelling Rule (2006, applicable 2009)

The FEDERAL TRADE COMMISSION has published in 16 CFR Part 305-RIN 3084–AA74 (FTC, 2006) an Appliance Labeling Rule for application on January, 1st, 2009. As compared to the previous programs it requests only the information at high speed on the label. There is an additional filing with DOE that will produce long term knowledge.

The Final Rule requires ceiling fan manufacturers to label their product packages with: (1) The fan’s airflow at high speed in CFM; (2) the fan’s power consumption in watts at high speed; (3) the fan’s airflow efficiency in CFM/Watt at high speed; and (4) a range of airflow efficiencies at high speed for standard-sized fans on the market as published by the Commission, in order to gain an idea of the efficiency of the product.

To obtain this information, manufacturers will have to test their fans pursuant the procedures required by DOE The Final Rule requires manufacturers to provide this information on a label affixed to the product packaging as well as in paper and online catalogs, of the model shown hereunder. The Rule also requires manufacturers to submit reports to the Commission with high speed airflow, power consumption, and airflow efficiency information for the applicable By statute, the Rule does not apply to fans produced before January 1,2009.

Figure 1-2: Ceiling fan appliance labelling rule from (FTC, 2006)



1.3.3.2 TAIWAN

Energy conservation label (2002)

Four kinds of electric fans are considered:
- Auto-revolving hanging fans
- Stand alone fans
- Ceiling fans
- Table fans

They are tested according to the Taiwanese testing standards CNS 2450, 2061, 597 and 547. For these fans, qualifying products shall meet or exceed the minimum requirements for airflow efficiency given in the following table. The airflow efficiency requirements depend both on the fan type and on the fan diameter.

Table 1-8: Taiwan energy conservation maximum SFP and minimum performance value (service value) for comfort fans (2002), by type and diameter

Fan type	Fan diameter [cm]	Performance ratio [m^3/min/W]	Performance ratio [W/(1000m^3/h)]
Auto-revolving hanging fans	35	1.01	16.5
	40	1.07	15.6
Stand alone fans	30	0.81	20.6
	35	0.87	19.2
	40	0.92	18.1
	50	0.91	18.3
	60	0.87	19.2
Ceiling fans	60	0.87	19.2
	90	1.15	14.5
	120	1.46	11.4
	130	1.45	11.5
	140	1.45	11.5
	150	1.47	11.3
Table fan	18	0.64	26.0
	20	0.66	25.3
	23	0.66	25.3
	25	0.67	24.9
	30	0.79	21.1
	35	0.86	19.4
	40	0.91	18.3

Tower fans, whose sales are important nowadays, are not reported.

Electric fans that meet the requirements are listed and can be found on the "Energy Label" website of Taiwan: http://www.energylabel.org.tw/product_en/product/list.asp (in Chinese only).

Labeled electrical fans are marked with the following label:

Figure 1-3: Taiwan energy label

The energy efficiency for qualified electrical fan products shall be measured according to relevant national test standards CNS 2450, CNS 2061, CNS 597 and CNS 547 or approved testing methods and conditions by Energy Commission.
(CNS: Chinese National Standards) – not found

1.3.3.3 CHINA

Former Minimum Energy Performance Standard –GB 12021.9 (1989)[6]

Five kinds of electric fans are included:
- Wall mounted fans,
- Floor table fans,
- Floor stand fans,
- Ceiling fans,
- Table fans.

For these fans, qualifying products must not exceed the maximum requirements for the motor input power [W] and the ratio Vmin/Vmax [%] given in the following tables. These power and air speed requirements depend on the fan type and on the fan diameter.

Table 1-9: Maximum power consumption as a function of fan diameter –GB 12021.9 (1989)

	Fan type (maximum consumption in W)				
Size [mm]	**Table fan**	**Wall mounted fan**	**Floor table fan**	**Floor stand fan**	**Ceiling fan**
200	26				
250	30	30			
300	42	42	42	42	
350	51	51	51	51	
400	59	59	59	59	
500				72	
600				103	
900					46
1050					55
1200					66
1400					77
1500					81
1800					84

Table 1-10: Maximum value of the lower fan speed (ratio of the maximum speed) –GB 12021.9 (1989)

	Fan type (Vmin/Vmax [%])				
Size [mm]	**Table fan**	**Wall mounted fan**	**Floor table fan**	**Floor stand fan**	**Ceiling fan**
200					
250	70				
300	65	65	65	65	
350	65	65	65	65	
400	65	65	65	65	
500				50	

[6] http://www.clasponline.org/productsummary.php?country=China&product=Fans%20(Residential)

600				50	
900					50
1050					50
1200					50
1400					50
1500					50
1800					50

Vmax: maximum speed at nominal power
Vmin: minimum speed at nominal power

Newly proposed MEPS & Labeling Scheme in China – GB 12021.9 200?

This standard, not yet adopted in 2007 will substitute the previous version. It is now called "Minimum Allowable Values of Energy Efficiency and Energy Efficiency Grades of AC Electric Fans". This standard specifies the energy efficiency grades, minimum allowable values of energy efficiency, evaluating values of energy conservation, test method and inspection rules for AC electric fans. This standard covers the desk fan, rotated-blade fan, wall fan, desk-floor fan, stand fan and ceiling fan driven by AC electric motor, with rated single-phase voltage no more than 250V, other rated voltage no more than 480V. The wording "stand fan" may very well include the so called tower fans. The Energy Efficiency demands would be higher with this new standard, and there is no longer the risk that the limiting values are used as design rules. Instead competition is created with a three grades labeling schemes (called 1, 2, 3) and grade 3 acts as a MEPS, due to its inclusion as a minimum value in the testing standard GB/T 13380-2007.

The energy efficiency of AC electric fans is divided into 3 grades (Table 1-11), with Grade 1 having the highest energy efficiency. The energy efficiency of different grades of products should not be lower than the requirements set out in Table 1-11.

Table 1.11 Energy efficiency grades of AC electric fans expressed in cubic meter/minute/Watt)

Type		Specifications (mm)	Energy efficiency value		
			Energy efficiency grade		
			1	2	3
Table fans, rotary fans, wall fans, box fans, stand fans	Capacitive	200	0.71	0.60	0.54
	Shaded pole		0.63	0.51	0.45
	Capacitive	230	0.84	0.70	0.64
	Shaded pole		0.65	0.57	0.50
	Capacitive	250	0.91	0.79	0.74
	Shaded pole		0.72	0.61	0.54
	Capacitive	300	0.98	0.86	0.80
		350	1.08	0.95	0.90
		400	1.25	1.06	1.00
		450	1.42	1.19	1.10
		500	1.45	1.25	1.13
		600	1.65	1.43	1.30
Ceiling fan	Capacitive	900	2.95	2.87	2.75
		1050	3.10	2.93	2.79
		1200	3.22	3.08	2.93
		1400	3.45	3.32	3.15
		1500	3.68	3.52	3.33

		1800	3.81	3.67	3.47

For tower fans the MEPS (equivalent to label 3 for the other types) is 0.40 cubic meter/minute/Watt.

There is a noise limit associated with the MEPS, given in table 1-12 hereunder, completed with the value 50 dB (A) for tower fans.

Table 1.12 Noise limits of AC electric fans

Type	Specifications (mm)	Max. Noise In dB(A)
Table fans, rotary fans, wall fans, box fans, stand fans	200	59
	230	60
	250	61
	300	63
	350	65
	400	67
	450	68
	500	(70)
	600	(73)
Ceiling fan	900	62
	1050	65
	1200	67
	1400	70
	1500	72
	1800	(75)

1.3.3.4 India

There is a rating in terms of star for ceiling fans under IS374:1979. A ceiling fan with a 1200 mm diameter should provide a certain flow at the maximum consumption of 50 W to get five stars.

1.3.3.5 International comparison

For ceiling fans, the USA Energy Star program requires both minimum air flow rates and minimum energy efficiency levels much more stringent than the Taiwan energy conservation label (about twice as stringent). However, the Taiwan energy conservation label not only covers ceiling fans but all other types of comfort fans. It is also interesting to note that the Energy Star program defines tolerances of 5 % for units that could be picked up in the distribution channel, but has no tolerance for the test of qualification of the model.
According to our information, the Chinese mandatory program is not directly comparable to these two voluntary programs since maximum electric consumption are defined as a function of the diameter of the fan and not in function of the air flow rate. These requirements mark a preference towards energy consumption independently of the primary function of the fan.

Task 1 summary

The primary function of comfort fans is "**to move air inside a room"** and the performance parameter to be kept is the air flow rate supplied by the fan. For ceiling fans, a secondary functionality consists in lighting up a room (ENERGY STAR program). This secondary functionality can be taken into account in the environmental impact analysis but will not lead to a specific category, both products : comfort fan and lighting kit, may be considered separately.

IEC standard covers most of the needs but not all, since tower fans –which are now very common in the EU- are not explicitly covered by the standard, which may apply anyway. Energy consumption and air flow information are to be supplied upon request only while there is a tolerance of 10 % on the rated air flow rate.

International legislation have already existed for some time in a few economies, with two approaches, either by setting maximum electric power consumption as a function of the diameter of the fan or based on a SFP approach (ratio between air flow rate and electric power). There is a new legislation in China that seems to be consistent with international standard and that may include tower fans.

SCOPE OF THE STUDY

The scope is limited to **residential** comfort fans.
Commercial names of the products identified are the following ones:

- Table-desk fan,
- Wall fan,
- Floor fan,
- Pedestal fan,
- Ceiling fan,
- Tower fan,
- Box fans.

The existing limit of 125 W found in the Prodcom categories may correspond to the residential range of products. This point will be analyzed in the following tasks. At the moment, no power or air flow rate limitation is put.

Table 1-11: Scope of the study

Comfort fans	**Table-desk fan, Wall fan, Floor fan, Pedestal fan, Ceiling fan, Tower fan, Box fans**	**Elec power < 125 W**[7]

[7] Cf. Prodcom categories analysis.

2 ECONOMIC AND MARKET ANALYSIS

2.1 Generic economic data

Treatment of prodcom data and the anomaly in export figures

Tables 2.1 and 2.2 give extraction results from prodcom data base.

Prodcom data show the massive imports but also a significant production and non negligible exports that we have to understand. The data have been treated to generate the net imports (imports-exports) for each EU country for the years 2000 to 2005 and the "production" (a few countries). The total of both figures is supposed to give apparent consumption.

The series of (fans production) values is pretty complete, see table 2.2, later in text.

The series of (export-import) values is pretty complete, see table 2.1, next page. The total EU values are of large interest because the internal trade is deleted. For EU25 as a whole, in 2005, 29 million units have been imported, 3 million units "manufactured" and 12.5 million units have been exported. The net balance is 25 800 000 units imported. The import and production figures have such consistency problems that we will not accept them, after further analysis.

Since we know that every production takes place abroad, we have a problem with "export" figures that all countries display. This phenomenon is usually in the range of 10 to 15% of imported fans. We can understand that for supply chain reasons, some countries may receive fans that they re-export to another country, presumably within the EU. However some countries have a special role in the supply chain and display a ratio exports/ imports well over the average: Slovenia (from 75 to 95%), Belgium (70%), Italy (40%), Slovakia or Germany (25%). Also one cannot understand a global re export of 10% of imported fans by the EU.

These percentages are given in physical terms. They increase even more when expressed in value. Exported products are declared over 25 Euros while imported are under 10 Euros, in the countries with no production. Anyway the result is that some countries appear as almost net exporters of fans (in Euros) while they don't manufacture them.

Table 2-1: Raw value of the difference (imports-exports) numbers in the sense of (prodcom 29.71.15.30) for six years and raw figures of imports and export values for year 2005

	In '000 units						In min. Euro	
							Imports	Exports
	2000	2001	2002	2003	2004	2005	2005	2005
Austria	189	332	345	365	849	330	9	3
Belgium	899	812	637	731	932	926	26	19
Cyprus	?	?	?	95	89	110	2	0
Czech Rep.	?	245	307	508	759	430	7	2
Denmark	261	200	286	238	349	274	6	3
Estonia	20	22	19	28	41	52	2	0,1
Finland	161	128	181	248	324	296	5	2
France	1651	1520	1753	2471	7015	4984	64	21
Germany	316 ?	2083	1672	4710	8619	2415	37	52
Greece	788	611	542	791	715	502	6	4
Hungary	?	2	?	1019	372	368	4	0
Ireland	286	323	180	205	249	164	2,4	0,1
Italy	1862	749	494	1412	3899	1069	34	45
Latvia	?	35	49	70	110	119	1	0,1
Lithuania	32	31	46	64	70	78	1	0,1
Luxemburg	23	24	35	26	53	45	14	0,2
Malta	?	?	?	68	95	75	0,8	0
Netherlands	819	1129	4594	4289	1169	1057	40	20
Poland	?	?	301	260	217	359	9	6
Portugal	377	361	297	191	575	864	10	3
Slovakia	76	138	182	346	577	291	2	0,5
Slovenia	?	14	17	32	81	?	1	2
Spain	421	87	539	325	2358	2748	46	51
Sweden	394	235	245	413	715	532	7	6
UK	3325	2186	4164	4683	7162	7842	47	21
EU 15 (prodcom totals)	10365	9623	15130	21298	36064	24721	199	85
EU 25 (prodcom totals)	**?**	**?**	**?**	**23395**	**37581**	**25829**	**207**	**71**
Romania	?	?	?	?	118	?	2	0,2
Bulgaria	?	94	?	185	109	210	2	0

Treatment of the anomaly in "production" of comfort fans

In the following table we have gathered "production" data. The stakeholders that we met were not aware of any production in the EU and so we wonder which type of "production" it is? Is it real?

Table 2-2: Production – Fans

	In'000 units						In min. Euro					
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Italy	1716	1927	1062	2339	2338	2184	39,403	46,154	48,102	46,169	51,808	49,906
Poland	? 0	? 0	637	1059	1423	? 1800	?	?	3,758	6,963	8,485	?
UK	3074	3014	2848	3897	3790	2707	105,412	101,171	95,114	96,834	105,222	95,715
Portugal	0	0	0	0	0	24	0	0	0	0	0	5,757
Sweden	171	168	181	0	0	0	12,820	12,841	14,095	0	0	0
Spain	? 1500	1470	1483	1671	1641	1922	?	18,993	19,613	18,293	20,273	20,470
Germany	?	?	?	?	?	3859	198,221	?	150,783	139,903	130,404	116,392
TOTAL	6461	6579	6211	8966	9192	12496	355,856	179,159	332,32	308,162	316,192	288,24

Is it a real production?
Italy, Poland, Spain and the UK show a stable "production" when demand varies, a fact that is in favour of the existence of a real factory with investment to amortise, not just a "branding factory". Germany can be considered to be in the same situation if we correct for some statistical errors. The situation of Sweden (closing of a factory in 2002?) and of Portugal (opening of a workshop in 2005?) seem also in favour of a real manufacturing. On total the production as reported by prodcom is around 9 million units, 30% of the apparent market (imports+production-exports) and is a real production.

Is it a production of fans?
Considering now the value declared for the products, the difference between foreign manufacture and EU manufacture is large. Imported products have a declared value as low sometimes as 4 or 6 Euros. EU produced fans are declared for 25 Euros per unit or more. The Swedish production which stopped was declared for 75 Euros per unit. Is it the same product?

It is time to formulate an hypothesis about the way the MS use the categories provided by Prodcom. In principle there are ventilating fans sections separate from comfort fans and called:
29.71.15.33 Roof ventilators
29.71.15.35 Other ventilators
Prodcom data are sometimes available for "roof ventilators" and "other ventilators" and indicate for instance an Italian production for 1998 and 1999: 1 300 000 units with a unitary value of 27 Euros.

Generally the figures are not available and we have to assume that they practically merged into the general category:
29.71.15.30 Table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor of an output <= 125 W
Where ventilation is not indicated and where comfort fans imports are dominant. The word "roof" in the general title of 29.71.15.30 could be seen as a reference to "roof ventilators". The existence of a EU production under this item is also in favour of our assumption. In practical term, the hypothesis will lead us to transfer from the comfort fans study to the ventilating fans study the production figures.

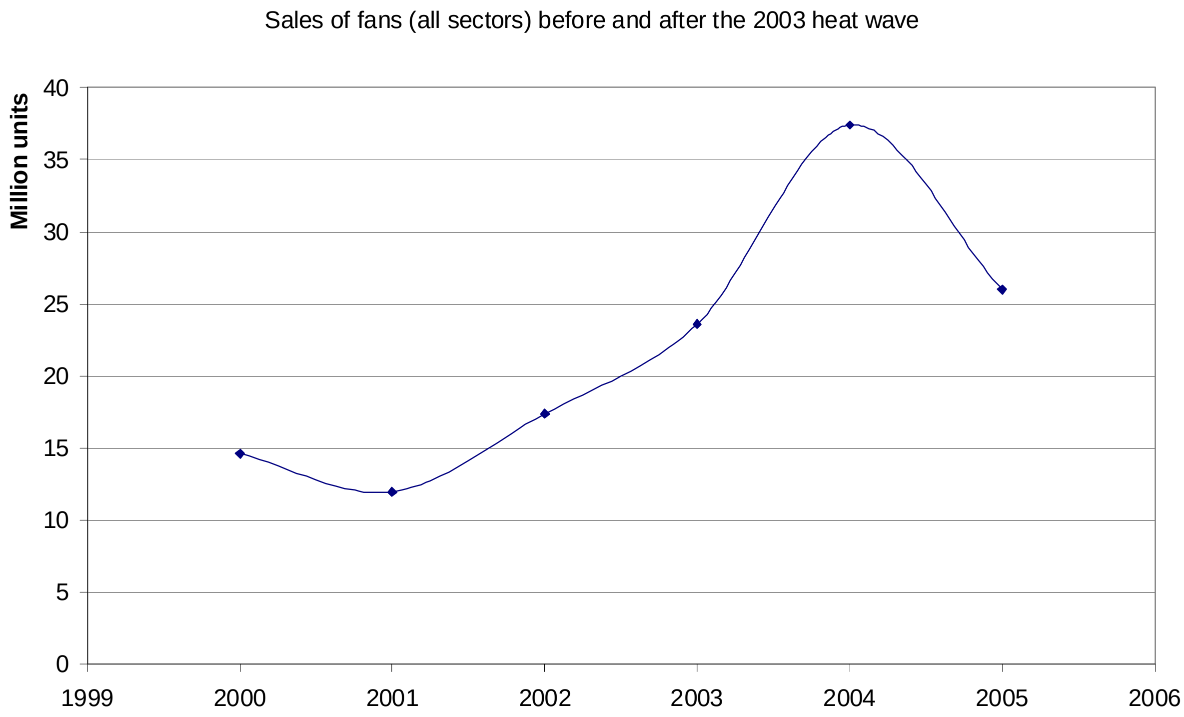
Table 2-3: Fans (in the sense of 29.71.15.30) – Imports in Euros

	2000	2001	2002	2003	2004	2005
Net Imports EU 15 (value) Mln. Euros	49,864	56,173	65,674	78,887	170,997	114,115
Net Imports EU 25 (value) Mln. Euros	?	?	?	100,017	195,112	136,047
EU 15 (value) Imported produced Mln. Euros	9,86	10,81	8,14	6,23	6,44	7,17
EU 15 (value) Exported produced Mln. Euros	27,39	33,94	33,82	26,05	28,00	27,71
EU 15 (value) produced Mln. Euros	28,55	?	?	?	?	28,36
EU 15 Lower Import (value) Euros	9,69 (GE)	8,76 (GE)	5,65 (PO)	4,14 (HU)	4,22 (BU)	5,63 (UK)

So we will not add the “production” figures to the (Imports-Exports) figures, and these last will be used as apparent consumption of comfort fans. The assumption is the following: if we interpret correctly the EU production as being a production of ventilation products, the national share (of ventilating fans) should be subtracted from the imports in the non producing countries to get the real comfort fans imports (and so subtracted from our imports-exports figures). In the producing countries, we have to admit that the imports are only comfort fans, but that the exports contain the ventilation products, and that the national share (of ventilating fans) have to be added to our previously computed import-export balance (because they are subtracted from the exports).

Internal consumption of Comfort fans (extracted from prodcom 29.71.15.30) remains the same after those corrections for the total of countries as in raw values. It’s only the history of sales on a country by country basis that could be changed. So we decided not to report here the altered values, to keep as close as possible to the original source. Since production of the other ventilation products is rather constant, even this history is not really altered. Table 2.4 gives the series of data, without gaps that will be used from now on. Figure 2.1 shows the estimated market, with the clear break generated by the 2003 heat wave.

Figure 2-1: market EU25



According to Prodcom figures post-treated as mentioned before, the market covered by imports is around 25 million units per year, displaying huge variations that we can relate with the 2003 heat wave: from 10 to 36 million units per year.

Table 2-4: Internal consumption of Comfort fans (prodcom 29.71.15.30) after filling the gaps

	Mln '000 units					
	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Austria	189	332	345	365	849	330
Belgium	899	812	637	731	932	926
Cyprus	100	100	100	95	89	110
Czech Rep.	300	245	307	508	759	430
Denmark	261	200	286	238	349	274
Estonia	20	22	19	28	41	52
Finland	161	128	181	248	324	296
France	1651	1520	1753	2471	7015	4984
Germany	2000	2083	1672	4710	8619	2415
Greece	788	611	542	791	715	502
Hungary	300	300	300	1019	372	368
Ireland	286	323	180	205	249	164
Italy	1862	749	494	1412	3899	1069
Latvia	30	35	49	70	110	119
Lithuania	32	31	46	64	70	78
Luxemburg	23	24	35	26	53	45
Malta	70	70	70	68	95	75
Netherlands	819	1129	4594	4289	1169	1057
Poland	200	200	301	260	217	359
Portugal	377	361	297	191	575	864
Slovakia	76	138	182	346	577	291
Slovenia	15	14	17	32	81	30
Spain	421	87	539	325	2358	2748
Sweden	394	235	245	413	715	532
UK	3325	2186	4164	4683	7162	7842
EU 15	13486	10780	15964	21098	34983	24048
EU 25	14599	11935	17355	23588	37394	25960

2.2 Market and stock data

The following data has to be gathered according to the EuP methodology:
In physical units, for EU-25, for each of the categories as defined in 1.1 and for reference years

- *1990 or 1995 (Kyoto ref.);*
- *2003-2005 (most recent real data);*
- *2010-2012 (forecast, end of Kyoto phase 1, relevant also for Stockholm, etc.);*
- *2020-2025 (forecast, year in which all new eco-designs of today will be absorbed by the market).*

the following parameters are to be identified:

- *Installed base ("stock") and penetration rate;*
- *Annual sales growth rate (% or physical units);*
- *Average Product Life (in years), differentiated in overall life time and time in service, and a rough indication of the spread (e.g. standard deviation);*
- *Total sales/ real EU-consumption, (also in €, when available);*
- *Replacement sales (derived);*
- *New sales (derived).*

The market of comfort fans is a market with thousands of imported models since the producing countries have a large internal market, but also due to the relative ease of entering that market (with little technical complexity). The US-DOE estimates that there are 2,500 basic models of ceiling fans sold in the U.S.A (i.e., units with essentially identical functional physical and electrical characteristics). When building our own data basis, we collected a short description of about 200 models sold in Europe on the internet. We have not been provided with any market study (we have not identified any study on this market) so we had to base the following only on the Prodcom values.

We built from table 2.4 an estimate of the stock in use (that is given in the table 2.5 below) on the basis of a simple change of trend of market due to 2003 heat wave and a ten years life duration: equipment reaching ten years is substituted by a new one, or put out of service in another way.

The main hypothesis are gathered hereafter:

- Market = Internal consumption between 2000 and 2005.
- There is a trend of + 10 % per year before 2000.
- Sales decrease by 2 % per year after 2005 (competition with air conditioning).
- Sales are stable before 1990.

The ceiling fans, very frequent in the US, are almost absent from EU residences – whereas figures are not available in Europe. According to DOE (FTC, 2006), 69.6 million U.S. households (or 65.1%) had ceiling fans in 2001 and there was 1 ceiling fan per household in Australia according to (AGO, 2006). Our figures include only products under 125 W and we can admit that they are not represented in our stock model. We can thus consider that the fans in the tables are either pedestal/table (the same mechanical parts) or tower fans.

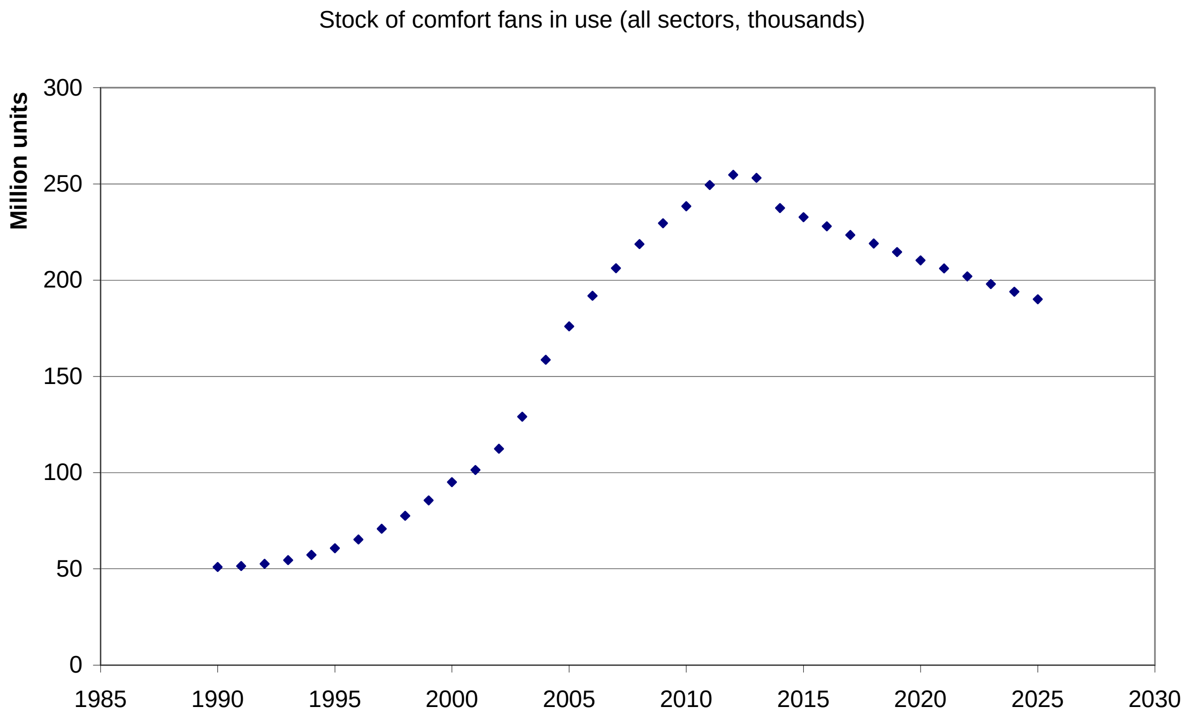
Table 2-5: Stock of Comfort fans in use (prodcom 29.71.15.30), all types, all use

	In '000 units					
	1990	1995	2000	2005	2015	2025
Austria	659	787	1231	2995	2958	2417
Belgium	3135	3741	5855	7719	8300	6782
Cyprus	349	416	651	904	986	806
Czech Rep.	1046	1248	1954	3478	3854	3149
Denmark	910	1086	1700	2416	2456	2007
Estonia	70	83	130	244	466	381
Finland	561	670	1049	1836	2653	2168
France	5757	6871	10753	24504	44674	36502
Germany	6974	8323	13026	27689	21647	17687
Greece	2748	3279	5132	6388	4500	3677
Hungary	1046	1248	1954	3588	3299	2695
Ireland	997	1190	1863	2292	1470	1201
Italy	6492	7749	12128	15248	9582	7829
Latvia	105	125	195	506	1067	872
Lithuania	112	133	208	420	699	571
Luxemburg	80	96	150	277	403	330
Malta	244	291	456	665	672	549
Netherlands	2856	3408	5334	15592	9474	7741
Poland	697	832	1303	2156	3218	2629
Portugal	1315	1569	2455	3832	7744	6328
Slovakia	265	316	495	1845	2608	2131
Slovenia	52	62	98	235	269	220
Spain	1468	1752	2742	7781	24632	20126
Sweden	1374	1640	2566	3753	4769	3896
UK	11594	13837	21656	39653	70291	57433
EU 15	46918	55997	87642	161977	215553	176122
EU 25	50904	60754	95086	176016	232691	190125

We observe that the penetration of comfort fans is far larger than in the case of air conditioners (hundreds of millions, not tens of millions), and that the 2003 heat wave has introduced a societal change leading to a doubling of ownership. Whatever happens in the meanwhile, the new habits will lead to a further increase in stock, compared with 2005 levels, as shown on Figure 2-1.

All of the 250 million comfort fans in the stock in 2010 (year of the maximum expected stock) are not in residential use. We have to estimate how many of those are used in dwellings, and how many, despite of being called such in customs statistics, will be used in working places. Our experience suggests half/half. The consumption figures and other environmental indicators will be determined with that assumption.

Figure 2-2: Total EU25 stock forecast



2.3 Market trends

2.3.1 Sales and climate change

As mentioned in Figure 2.1 page 25, sales of comfort fans in the EU has been increasing from 10 to 25 million units from 2000 to 2005, with a peak value for sales in 2004 at 35 million units, the year after the heat wave. It is interesting to note that the effect of the heat wave seems to show that the same phenomena occurred for comfort fans as for air conditioners: demand in 2003 was higher than the stock available and sales exploded really in 2004, when adding the fear of a new heat wave to the 2003 demand not answered. 2005 sales are then comparable to 2003 sales. Nevertheless, because of a low price, sales are much more volatile than for air conditioners (more expensive by a factor higher than 10 in general). It can be expected, and has been translated in the stock modeling with simple hypothesis, that the development of the air conditioner market will lead to a saturation of the sales of comfort fans.

2.3.2 Technical characteristics

It should be said that very few information is generally made available on comfort fan performances and technical characteristics, and that it is an obstacle for end-users to choose.

As a result of the lack of EU data bases, we had to build our own data basis from internet and store surveys (two hundreds of entries[8]) for the products which are really sold in Europe, with the following items:

- Trade mark
- EU distributor
- Manufacturer

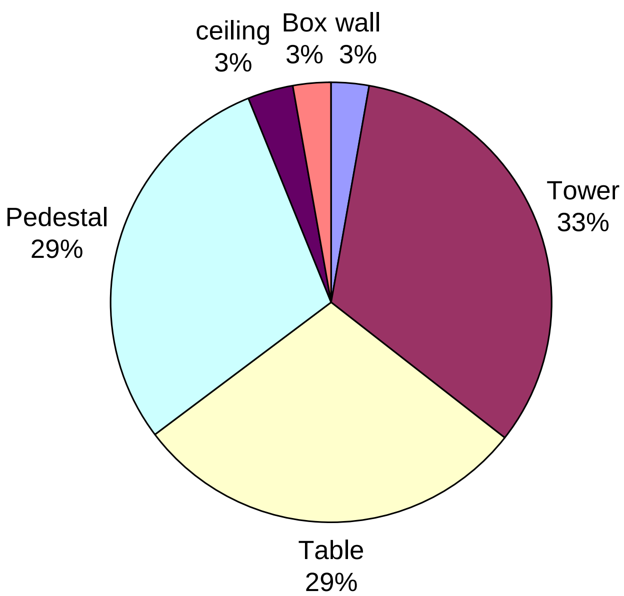
[8] 26 brands with at least 185 distinct models

- Year
- Reference
- Type
- Speeds number
- Electrical P (W)
- Diameter (cm)
- Air velocity
- Air flow
- Oscillating Horizontally?
- Oscillating Vertically?
- Other options
- Price

We can infer two conclusions from the making of this database:
- we observe that the 125 W limit is perfect to separate the residential and tertiary products from whatever other products; this is confirmed when observing the wattage graphs hereafter.
- We also observe that table and pedestal fans are the same devices with a smaller or larger column; this is also confirmed when comparing wattages on figures 2.6 and 2.7.

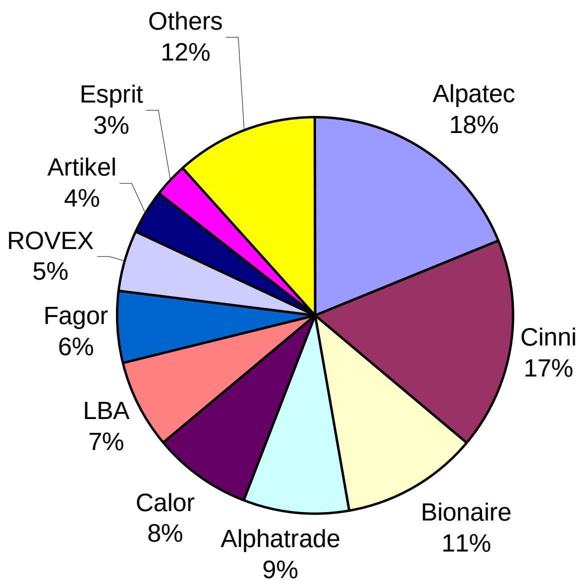
The shares of types in the offer of models are dominated by Pedestal, Table and Tower fans as shown in the figure below.

Figure 2-3: Model database of comfort fans, representation of categories in %



The brands are relatively concentrated but there is also non branded equipment. The “big brands” which appear seem not to be manufacturers themselves but want to offer a complete directory to customers. The pie chart shows the significance of the brands in our data base

Figure 2-4: Main trade marks



The bar charts below shows the average power demand by fan type.

Figure 2-5: Model database of comfort fans – table fans-, power input

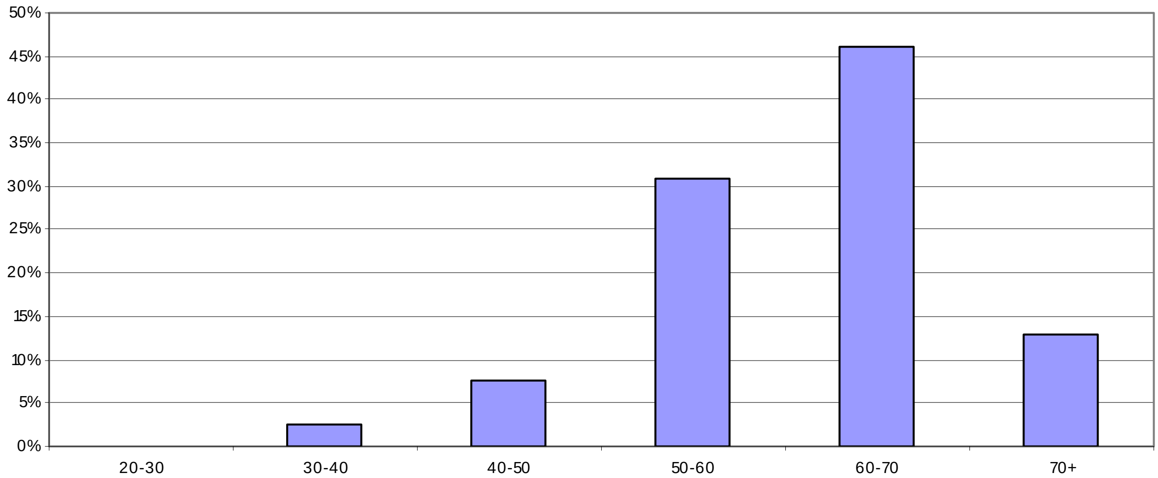
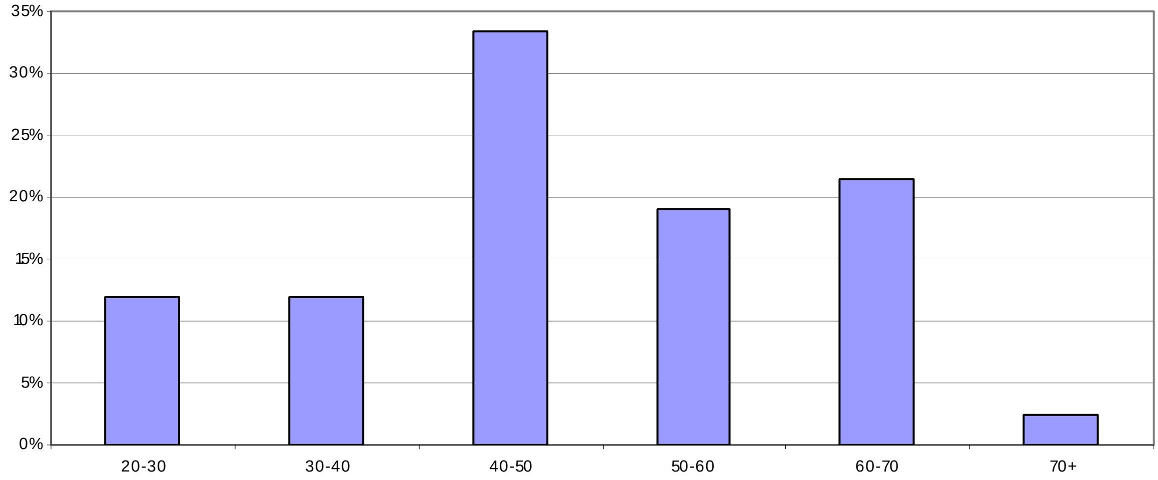


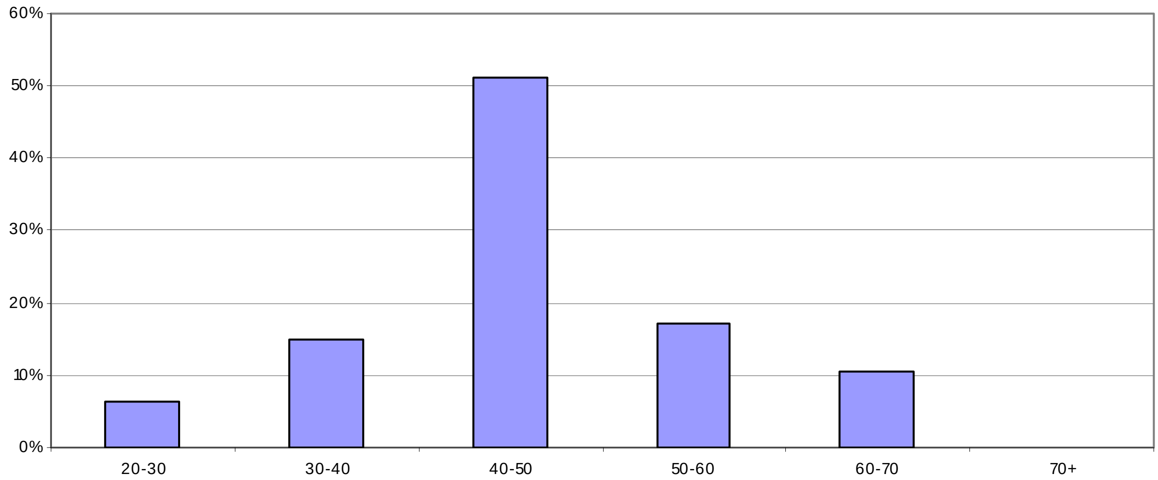
Figure 2-6: Model database of comfort fans –pedestal fans-, power input



The 60 W models are really dominant in the first case while the whole range from 40 W to 60 Watt is the average of the distribution in the second situation. However, 50 W is suitable to summarize the market. The average (model number weighted) is 58 Watt for pedestal and 46 Watt for table fans.

For tower fans, the electric demand is lower but the airflow is far lower (according to manufacturers declarations). However comfort cannot be compared since a vertical zone of flow may be very efficient compared to a usual fan moving air all around the room. By the way, the values of flow rate are only two for tower fans and the way of measuring is unclear. Hereunder the bar chart of electricity demand.

Figure 2-7: Model database of comfort fans – tower fans-, power input



Here the average power demand is 43 W and the dominant model uses 40 W, but not for the same service.

It should also be noted that for tower fans remote control is becoming a common function. In addition, specific features have been observed in the past two years:

- development of several associated functionalities that need power (USB key reload, insecticide diffuser, ionizer, lamps …),
- new table and pedestal fans have more plastics and less metals, and most recent products are signaled as RoHS compliant,

- nevertheless, the weight of the "pedestal" in the fan assembly is growing to ensure better balance of the fan.

2.4 Consumer expenditure base data

According to the MEEuP methodology, task 2.4 should contain:
For each of the categories defined in subtask 1.1:
Average consumer prices, incl. VAT, in Euro.
Determination of applicable rates for running costs and disposal, per EU Member State, specifically

- *Electricity rates (€/ kWh);*
- *Consumer prices of other consumables filters*
- *Repair, cleaning and Maintenance costs (€/product life);*
- *Installation costs (for installed appliances only);*
- *Disposal tariffs/ taxes (€/product);*

This section provides data on expenditure of comfort fans in each of the EU Member States. Three types of expenditure are considered:

- initial cost (price),
- running costs and
- disposal costs.

Running costs include electricity consumption, and repair and maintenance costs, whilst disposal costs include disposal taxes and tariffs.

Additionally, information on the discount rate is also presented.

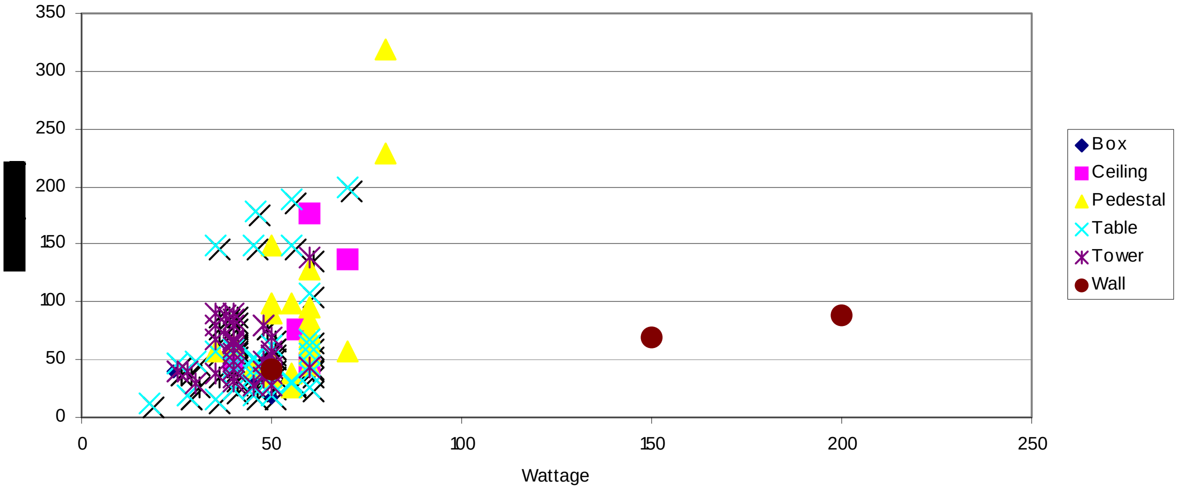
2.4.1 Consumer price

We have completed this paragraph by calculating average prices for comfort fans gathered in our database of sold models.

Price variations are not caused by brand (very few "big names") or performance but by finishing of aspect (steel, chromium) and the appearance of plastic or not.

Price are very different among tower, wall, ceiling and table/pedestal. The type is not the best explanatory factor. There is an influence of Wattage as can be seen in the figure below but somehow erratic, except for the very few wall fans.

Figure 2-8: Price as a function of Wattage



Average and minimum prices in the product database are as follows in table 2.6. Pedestal and table models with very high prices corresponding to a very limited part of the market have been removed in order to avoid price distortion. Revised average prices are consistent with models prices on the internet or in large retails and supermarkets.

Table 2-6: Prices in data base in euros

Type	Average price	Minimum price
Box	32,5	17
Ceiling	97,4	47
Pedestal	70,5	25
Table	50,0	12
Tower	57,4	27
Wall	60,5	42
Weighted according to DB	59,3	23,4

For table, pedestal and box fans the minimum public price is comparable with declared import or production prices but the average prices show a large margin that can be understood as opportunity pricing (margins factors like 2, 3 or 4). These average selling prices will be the ones kept for the base cases in task 5 and following ones, while the average import value is only 7 euros, as reported in the analysis of Prodcom data in paragraph 2.1.

2.4.2 Running costs

Electricity prices provide a key element of the running costs for comfort fans. We will keep the average 0.158 euro / kWh. More detail can be found in the study on air conditioners. Other running costs relate to repair and maintenance. Because of the low initial price and no installation cost, very little maintenance is thought to be done on comfort fans that is then not considered in the study.

2.4.3 Disposal costs

Visible fees paid as ecotaxes for comfort fans exist in various Member States and are included in the product price.

2.4.4 Economic Indicators

Discount rate is equal to 2 %. More detail can be found in the study on air conditioners.

Task 2 summary

Concerning generic economic data, valuable information has been obtained from the analysis of Prodcom data and better data could not be supplied by stakeholders.

An EU market estimate has been supplied. Prodcom analysis and average lifetime of appliances have helped finding the stock figures of appliances. Sales of comfort fans in the EU has been increasing from 10 to 25 million units from 2000 to 2005, with a peak value for sales in 2004 at 35 million units, the year after the heat wave. It is interesting to note that the effect of the heat wave seems to show that the same phenomena occurred for comfort fans as for air conditioners: demand in 2003 was higher than the stock available and sales exploded really in 2004, when adding the fear of a new heat wave to the 2003 demand not answered. 2005 sales are then comparable to 2003 sales.

All of the 250 million comfort fans in the stock in 2010 (year of the maximum expected stock) are not in residential use. We have to estimate how many of those are used in dwellings, and how many, despite of being called such in customs statistics, will be used in working places. Our experience suggests half/half. The consumption figures and other environmental indicators will be determined with that assumption.

A database of models sold on the EU market has been constituted independently from the stakeholders.
Frequency of the different categories are 29 % for the table, 29 % for the pedestal fans (basically the same product) but more surprisingly 33 % for tower fans. A typical electric input is identified by category: 40 W for tower fans, 50 W for table fans, 60 W for pedestal fans. Many brands appear (as well as non branded products) with significant appearance for Alpatec, Cinni, Bionaire and Alphatrade.

Concerning expenditure base data, the part on consumer prices has been completed by analysis the database of models:
- it has been found independent from Wattage,
- prices are mostly dependant on the need for a table (average price for table fans is 50 Euros) or being self standing (70 Euros),
- there is no relationship between the prices to end-users and the import prices which are all under 10 Euros.

The installation and maintenance costs are thought no to be relevant for this type of product. Disposal costs are likely to be less than recycling fees and are normally included in the product price. Electricity price and discount rate are respectively 0.158 euro / kWh and 2 %.

3 CONSUMER BEHAVIOUR AND LOCAL INFRASTRUCTURE

Scope: Consumer behaviour can —in part- be influenced by product-design but overall it is a very relevant input for the assessment of the environmental impact and the Life Cycle Costs of a product. One aim is to identify barriers and restrictions to possible eco-design measures, due to social, cultural or infra-structural factors. A second aim is to quantify relevant user-parameters that influence the environmental impact during product-life and that are different from the Standard test conditions as described in Subtask 1.2.

3.1 Real Life Efficiency

We will discuss here the usage pattern of fans.

Two points, amongst the several topics that can be found in the MEEuP methodology for task 3.1, are relevant for comfort fans: characteristics and frequence of use and the avaibility of fan speeds.

3.1.1 Hours of use

Hours of use, field study by (Nicol, 2004)

Scientific literature exist on the relationship between the use made of fans and temperature (indoor and outdoor) and namely the papers by (Nicol, 2004).

Nicol used results from field studies to make an estimation of the use of different controls (among which comfort fans) that can help occupants to improve their thermal comfort. The data collected about the use of comfort fans is binary: switch on or switch off. The likelihood that a comfort fan is being used can be said to depend on the thermal environment and, in particular, the temperature. Thus, as the indoor or outdoor temperature increases, the likelihood that a fan is switched on increases. As a result, Nicol carried out a probit analysis to illustrate how the proportion of people who use fans change with outdoor and indoor temperatures. The probit procedure assumes that the likelihood of an event happening increases as the “intensity” of the stimulus (for instance, temperature) increases. The model used in this study is the Logit model. The probability of a particular event (fan to be switched on) is therefore linked to the variable (temperatures) by the equation hereunder.

$$p = e^{(a+bx)} / (1 + e^{(a+bx)})$$

where:
p: probability of an event having taken place
x: variable
a and b: constants

In this study, Nicol determined a and b coefficients thanks to field studies (he found out the best fit to experimental points). The logit approximations are compared to results from field studies from different countries on Figures 3.3 and 3.4. The relatively low use of fans by the subjects in the European survey may be caused in many cases by the absence of the necessary fan. Two populations in these data that have relatively good access to fans are those in Greece and in Pakistan. Figure 3.5 shows the European probits separately by country. It suggests that there is a difference between countries in the availability of fans. The probit for Greece is similar to that for Pakistan, shown in Figure 3.5. The UK probits in Figures 3.3 and 3.4 follow that for Pakistan but stop short at 25 °C outdoor temperatures and 28 °C indoors in the UK. This suggests that in the surveyed buildings, UK workers generally have fans—and use them—if they are needed. The analysis therefore suggests that if fans are provided, the use of fans will follow the pattern given by the Pakistan/Greece probit curves.

This suggests that 20 % of building occupants use fans at 18 °C, 50 % at 23 °C, and 80 % at 28 °C. At outdoor temperatures above 30 °C, the use of fans is almost universal; below 15 °C, it is almost absent.

Finally, the values proposed by Nicol for Europe are given in the table below. By this way, the proportion of fans in use is linked to outdoor and indoor temperatures.

Table 3-1: Percentage of people using a fan as a function of outdoor air temperature and indoor globe temperature

	Outdoor temperature [°C]		**Indoor globe[9] temperature [°C]**	
	Intercept a	Slope b	Intercept a	Slope b
Comfort fans running	-3.80±0.25	0.110±0.014	-8.36±0.66	0.243±0.026

Figure 3-1: Proportion of offices with fans running at different indoor globe temperatures. The lines are the logit approximations.

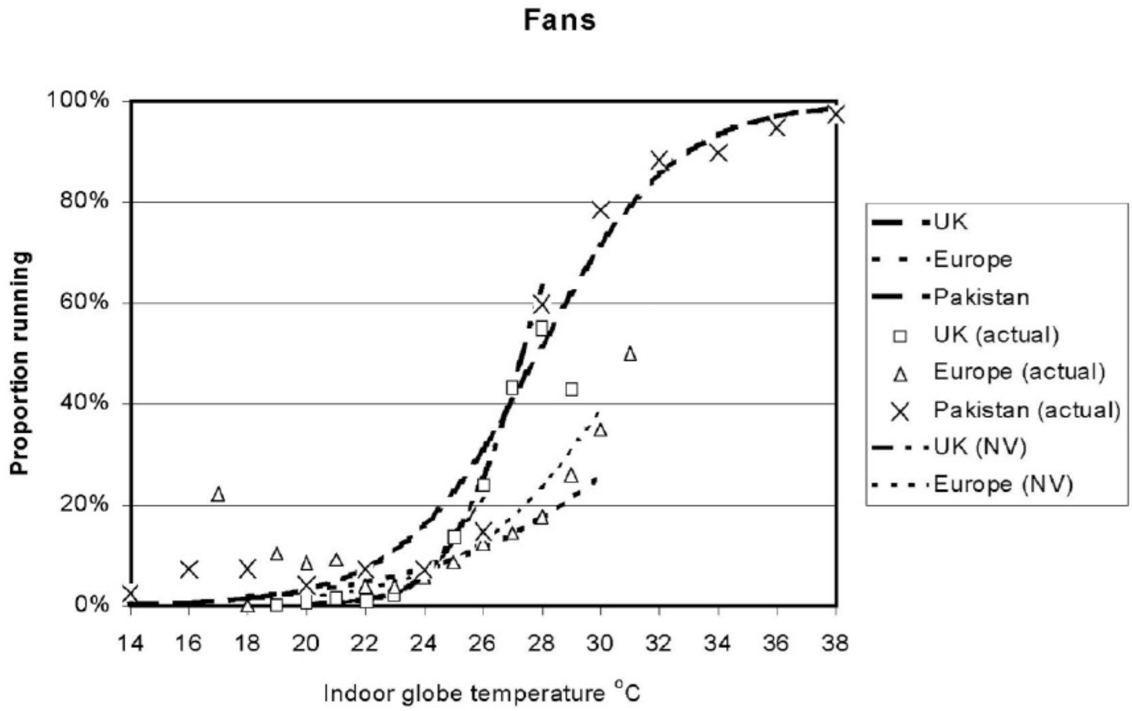


Figure 3-2: Proportion of offices with fans running at different outdoor air temperatures. The lines are the logit approximations.

[9] Globe temperature refers to the instrument used to measure a temperature that is close to the operative temperature (temperature felt including radiations from the walls, used in comfort definitions).

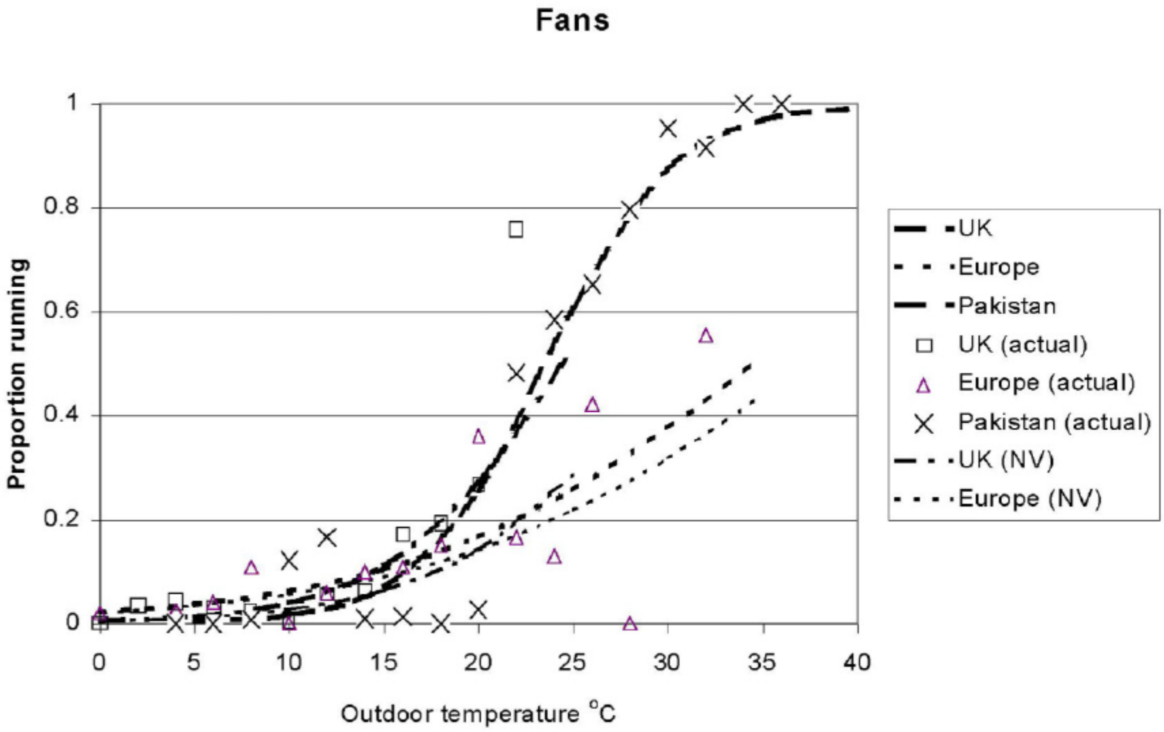
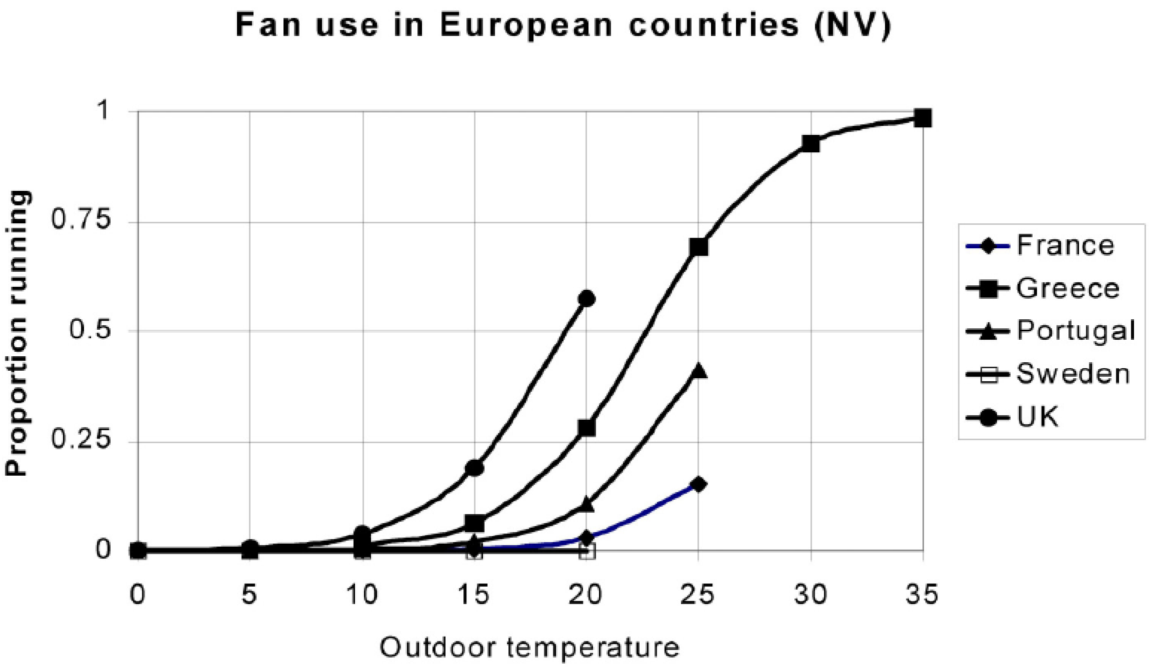


Figure 3-3: Probit lines for fans running in naturally ventilated (NV) buildings in different European countries.



The problem of this approach is that we do not have results on a country by country basis. Also, fans all have various speeds and this methodology does not enable to identify the importance of operation at reduced speed.

Thermal comfort and fan use

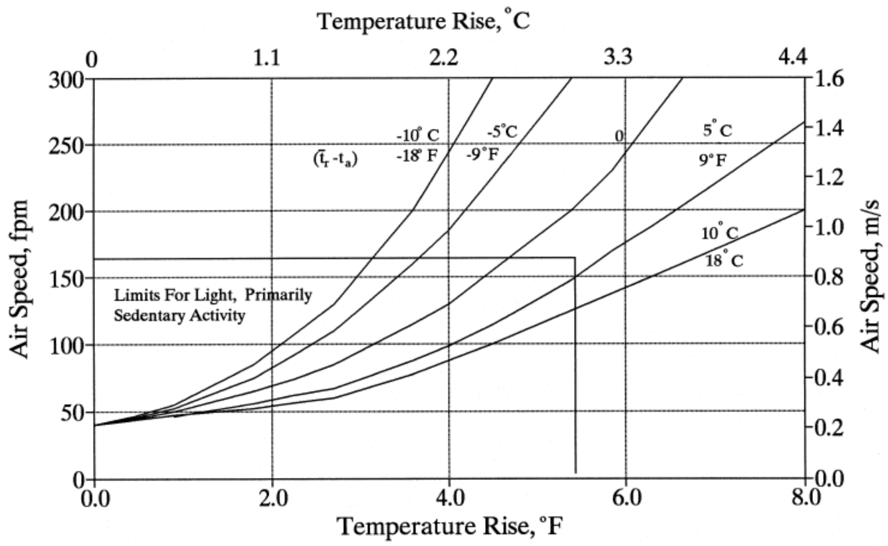
In order to understand the time fans are used and the speed of operation that are used, it is necessary to come back to the comfort definition itself. What the user is expecting from the product and what he obtains finally determine its way of using it. Hence, the number of hours of operation will be estimated from the study of discomfort.

Numerous human thermal comfort studies have been carried out to analyze and quantify the positive and negative effects on thermal comfort of air flows and in particular of airflow due to comfort fans. (Arens, 1997) showed that the cooling effect of personally controlled fans was approximately 1 °C by 0.1 m/s increment of air speed. This study was carried out under specific conditions, mainly air temperature from 24 °C to 31 °C, activity level of 1.2 met (sitting in activity) and clothing equivalent to 0.5 clo (summer light clothes). Furthermore, Arens compared his results from experiments to results obtained with Fanger's indexes and found that they were close with a 5 % difference. Effects of ceiling fans on the summer comfort zone have also been studied by (Roshles, 1983) in experiments gathering eight subjects. They considered that air movement was pleasant up to 1 m/s at 29.5 °C and the turbulence of the flow was a beneficial aspect.

First of all, potential cooling benefits of air flow in summer are presented in several standards: it translates the idea the summer thermal comfort zone may be extended by increasing the air speed. For instance, the 2004 ASHRAE standard 55 proposes in summer conditions, to relate the comfort temperature to the air speed and the difference between the mean radiant temperature and ambient temperature (ASHRAE, 2004) (figure below). The combinations of air speed and temperature defined by the lines in this figure result in the same heat loss from the skin. The indicated increase in temperature pertains to both the mean radiant temperature ant the air temperature. That is, both temperatures increase by the same amount with respect to the starting point. When the mean radiant temperature is low and the air temperature is high, elevated air speed is less effective at increasing heat loss.

The 2004 ASHRAE standard 2005 contains some limitations and obligations when air speed is increased inside a room. Thus, elevated air speed may be used to offset an increase in the air temperature, but not by more than 3 °C above the values for the comfort zone without elevated air speed. The required air speed may not be higher than 0.8 m/s in order to avoid disturbance like paper flying and draft but also because there are large individual differences between people with regard to the preferred air speed. In this way, the elevation of air speed must be controlled by affected occupants and adjustable in steps no greater than 0.15 m/s. This kind of approach consisting in expressing the cooling sensation (temperature rise in °C) of uniform air flow according to the air speed can also be found in many research works like for example those of (Szokolay, 1998).

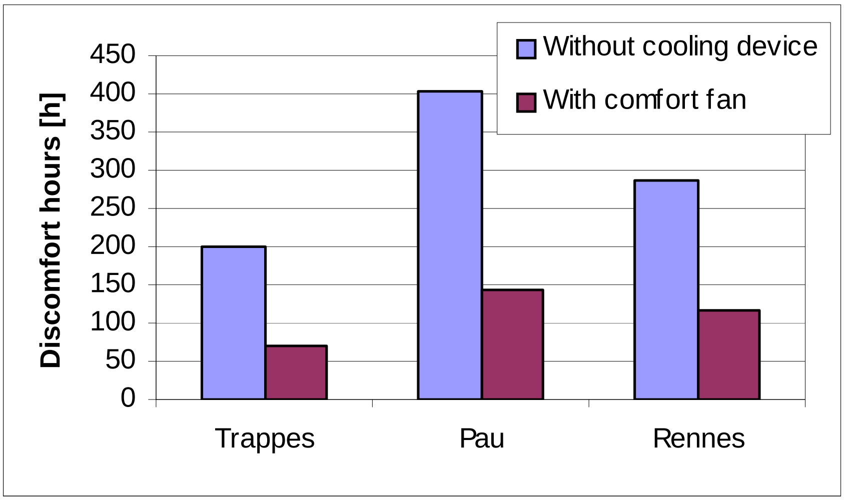
Figure 3-4: Airspeed required to offset increased temperature, source ASHRAE



This approach is based on comfort indices developed by (Fanger, 1970): the PMV ("Predicted Mean Vote") and the PPD (Predicted Percentage of Dissatisfied). These indexes mainly depend on six parameters, four ambiance ones (air temperature, mean radiant temperature, air velocity, relative humidity) and two concerning the individual (physical activity, clothing thermal resistance). In order to predict thermal sensations, Fanger assumed that the human thermal balance must be null which leads to a first formula. It means that the individual exactly looses the heat produced by the metabolism. In addition, Fanger realized experiments in climate chambers to correlate metabolism with mean skin temperature and sweating. In more details, the PMV equation assumes that deviations from the human thermal balance vary with thermal comfort vote. A PMV equal to zero represents the optimum comfort when the thermal balance is null. This index can vary from –3 (cold) to 3 (hot). It is also possible to predict the reaction of individuals thank to the PPD index that aims at calculating the expected number of thermally dissatisfied people in a group according to the PMV. PMV and PPD are used in several standards where comfort zone are often defined by limiting the PMV between –0.5 and 0.5 (ie less than 10% of unsatisfied people according to the PPD). In a further study (Fanger, 1974), Fanger stated that the quantitative influence of air velocity is in good agreement with PMV and PPD equations.

Based on these indices, a study has been carried out by (Grignon-Massé, 2007) to assess the benefits of fans in terms of comfort in three French cities by using experimental measurements of air speed along with building simulations with free temperature and humidity evolution; it was made possible to access inside climatic conditions when using a comfort fan. It appears that the number of discomfort hours are at least divided by a factor of three with regard to a room without cooling device (figure below). With a comfort fan, occupants would have to face from 70 discomfort hours in Trappes to 145 in Pau, which correspond respectively to 6.4 % and 13.3 % of the occupation time.

Figure 3-5: Number of discomfort hours over the summer period for 3 French locations, from (Grignon-Massé, 2007)



Hence it was possible to calculate the number of hours with the fan on, ranging from 200 h to 400 h for a dwelling representative of the stock of residential housing in France. Translated in term of equivalent full load hours, it gave between 60 and 100 hours in this case, meaning that in average units was operated at lower than rated flow rate, between 25 % and 33 %, meaning that for an important number of hours, the fan was operated at reduced speed only. The same calculation for Spain (Madrid) gives more then 2000 hours of occupation above the set point limit (25 °C or 26 °C) with the larger part of hours above 28 °C, so that average speed is likely to increase.

Estimate of the total number of use

Starting from the calculation in task 4 of the air conditioner study, we can determine the number of hours when a cooling load appears – temperature set point is not respected. During these hours, comfort conditions (set point of 25 or 26 °C for CY and MT) will not be reached. Hence, in a building without air conditioning and with a fan, the fan is likely to be used. This calculation leads to a number of hours lying between 25 hours in Ireland and more than 1000 hours for Southern countries. Sales weighted average figures in table 2.4 are used to determine an average EU value of 320 hours for Europe.

3.1.2 Airflow oscillations

Regarding comfort fans whose air flow is not uniform several studies have been carried out based on human experiments. A study carried out by (Konz, 1983) aimed at comparing fixed fans with oscillating fans. The exposed subjects preferred oscillating fans to fixed ones. A second set of experiments consisted in exposing the subjects to air movements at different angles to the front of the body. It appeared that angle was not a significant parameter in terms of thermal comfort.

Another documented effect of air movement is the human response to the power spectrum of the turbulent airflow provided by a comfort fan. In fact, like other receptors contained in the skin, heat receptors are sensitive to some stimulation frequency ranges and have peak response at certain frequencies. Thus, (Oelsen, 1985) determined that human thermal receptors had a significant peak in response around 0.5 Hz in cool ambiant and related velocities at a 0.5 Hz gust frequency to equivalent uniform air speed for identical cooling sensations (discomfort in this case). For example, a mean air speed of 0.4 m/s at a 0.5 Hz frequency will provide the same cooling sensation as a uniform air speed of 0.6 m/s. This kind of experiments has been also processed in hot ambiances where the human thermal response to the cooling sensation of air movement has a significant peak around 0.4 Hz (Konz, 1983).

3.1.3 Standby energy consumption

(AGO, 2006) gives the results of a survey of the standby energy consumption of comfort fans led in Australia in 2005. The results are gathered hereafter for the 3 types of fans identified in the study.

“Pedestal fan ownership was found to be 0.57 units per house in 2005, with ownership probably steady. About 99 % of units were found to have a hard off switch and about 97 % of units were found to use 0.0 Watts in off mode. “

”Tower fan ownership was found to be 0.49 units per house in 2005, with ownership probably steady. About 95 % of units were found to have a hard off switch and about 97% of units were found to use 0.0 Watts in off mode. “

”Ceiling fan ownership was found to be 1.02 units per house in 2005, with ownership probably steady. As all units were found hardwired or inaccessible, 97% of units were assumed to use 0.0 Watts in off mode. The other 3 % had remote control capabilities and were assumed to use an average of 2.5 Watts in passive standby mode.”

Observations of models on the EU market when constituting the database of models confirmed that comfort fan standby possibly had 3 standby modes to be considered that are covered by the definitions of Lot 6:

- Disconnected.

- 0 watt off-mode: the comfort fan is connected to a power source but not drawing energy; it is galvanically switched off;

- Lot 6 standby: some fans may have either a remote control (identified in the market trends for tower fans) and also some have a LCD screen to show the status of the fans (fan speed), also there may be a timer, etc. This seems to be the case also for ceiling fans according to (AGO, 2006) nevertheless no model has been identified on the EU market of ceiling fan with a remote control, type of fan which is very uncommon on the EU market anyway.

Then it seems it is only useful to consider standby consumption for tower fans.

3.2 End-of-Life behaviour

The required content of this subtask as defined in the EuP methodology is:
Identification of actual consumer behaviour (avg. EU) regarding end-of-life aspects. This includes:
- *Economical product life (=actual time to disposal);*
- *Repair- and maintenance practice (frequency, spare parts, transportation and other impact parameters);*
- *Present fractions to recycling, re-use and disposal;*
- *Best Practice in sustainable product use, amongst others regarding the items above.*

An economic life of **ten years** is assumed.
No maintenance is supposed to be done because of the low price of the product itself.
Comfort fans are included in the WEEE scheme; the study of environmental impact will thus be led in a **post WEEE scenario**.

3.3 Local Infrastructure

3.3.1 Interaction with ventilation, cooling and heating

First we can conclude from the knowledge of the air speeds (m/s here, mm/s in the case of ventilation) that there is no interaction between both equipment : ventilation and comfort fan.

It’s not so easy to conclude about the potential interactions between air conditioners and fans.

First, because air conditioners sold in Europe provide a “ventilation” mode which is not ventilation indeed but air movement, like comfort fans. So the interaction expected is that people stop using comfort fans when they purchase an air conditioner.

Second because the comfort fans, as any other appliance, increases the cooling load. However a typical value of heat dissipation by a fan, like 50 W, is less than one person more, and less than most other appliances.

However in the USA, for cultural and historical reasons, there is at the same time in residences an air conditioner and a ceiling fan. So there is some literature about their interaction. This is a source of information about the possible interaction : is there a benefit to have it? According to the official US-DOE view (FTC, 2006) ceiling fans can improve the comfort of a home by circulating air to create a draft throughout a room. For homes using air conditioning, a ceiling fan allows consumers to raise the thermostat setting about 4 °F (2,2 °C) with no reduction in comfort. In temperate climates, or during moderately hot weather, ceiling fans may allow consumers to avoid using air conditioning altogether. A larger fan blade provides comparable cooling at a lower velocity than a smaller blade. DOE recommends a 90 or 110 cm diameter fan to cool a room of up to 21 square meters, while fans that have diameters of 130 cm or more should be used in larger rooms. In the winter, by reversing the blade direction and operating at low speed, ceiling fans can provide a gentle updraft, which forces warm air near the ceiling down into the occupied space.

Some scientific literature tried to quantify the potential energy savings of comfort fans (mainly ceiling fans) and to try to improve their efficiency as air conditioners. The results are not so firm as the official US view. Regarding energy savings, simulation studies have demonstrated that using ceiling fans can lead to energy savings or wasting in comparisons with air conditioners according to set point chosen by end-users. For example, according to (James, 1996), using ceiling fans combined with raising a home's temperature 1.1 °C (2° F) will generate about a 14 % net savings in annual cooling energy use (subtracting out the ceiling fan energy and accounting for internally released heat). This savings drops to 2.6 % with a 0.56 °C increase in set point and to a negative 3.7 % savings with only a 0.28 °C increase in set point. If the thermostat is not adjusted at all for fan use, cooling energy use may increase by as much as 15 %.
Comfort fans can also extend the natural ventilation season when the air conditioner is not used, allow for higher thermostat set points when the air conditioner is used and therefore should lead to energy savings. However, (James, 1996) mentions that a survey of 400 households in Florida does not indicate cooling energy savings due to ceiling fans because of inappropriate thermostat settings.

EREC[10] reports an interaction between heating and ceiling fans. However it requests the ceiling fan to rotate in opposite directions in Winter and Summer.

3.3.2 Installation guide for good practice

There is an interesting guide from the UK administration under web site Cooling Fan UK. We extract some significant recommendations:

-About sizing
The table below will help you choose the most appropriate fan to suit the size of the room you wish to cool:
Selecting the best fan size

[10] DOE's Energy Efficiency and Renewable Energy Clearinghouse (EREC).

Room Area (metres2)	*Ideal Fan Width (sweep)*
Up to 10	*900 mm (36 inches)*
10-20	*1200 mm (48 inches)*
15-30	*1400 mm (58 inches)*
+30	*Two or more fans*

About winter and summer use of ceiling fans

- *Ceiling fans can be suspended in rooms with high ceilings.*
- *Should be installed with a clearance of at least 2100mm above floor level.*
- *Should be located higher than the light fittings to avoid flickering shadows, or you can install a unit with a light fitting attached..*
- *If more than one fan is required, the spacing between fans should be as least three times the fan width.*
- *A reversing function enables some fans to be used in winter to bring down the heat that builds up at ceiling level.*
- *Look for variable speed control and curved blades to produce more air movement.*
- *Average purchase cost £50-£200, plus installation.*

Task 3 summary

The review of thermal comfort literature enables to identify several parameters that can affect the perception of the thermal comfort supplied by the fan air speed and consequently the real life number of hours of use of comfort fans. Most fans have several fan speed with substantially lower efficiencies than the rated efficiency. The EU sales weighted average equivalent number of operation at full load, considering constant part load efficiency, is about 150 hours.

Comfort fans supply thermal comfort by increasing air speed around the body. First we can conclude from the knowledge of the air speeds (m/s here, mm/s in the case of ventilation) that there is no interaction between ventilation and comfort fans.
Comfort fans can be associated with air conditioners. Energy savings can be achieved with the same level of comfort whether air conditioner control is properly adapted to that configuration.

At the moment no specific parameter has been identified that can be seen as a barrier for ecodesign measures.

4 TECHNICAL ANALYSIS EXISTING PRODUCTS

Introduction

The likely content of the task is defined in the MEEuP methodology as follows.

Scope: This entails a general technical analysis of current products on the EU-market and provides general inputs for the definition of the Base cases (task 5) as well as the identification of part of the improvement potential (task 7), i.e. the part that relates to the best existing product on the market.
- 4.1 Production phase
Product weight and Bill-of-Materials, distinguishing materials fractions/ electronics modules (weight) at the level of the EuP EcoReport Unit Indicators as proposed in the MEEUP report. This includes packaging materials and an assessment of the primary scrap production during sheet metal manufacturing.
- 4.2 Distribution phase
Volume and weight of the packaged product.
- 4.3 Use phase (product)
- Rated annual resources consumption (energy, water, detergent) and direct emissions during product life according to the test standards defined in subtask 1.2 ;
- Assessment of resources consumption (energy, water, detergent) and direct emissions during product life in off-standard conditions, i.e. at variable load.
- 4.4 Use phase (system)
- 4.5 End-of-life phase
Considerations regarding the end-of-life of materials flow for
- Handling as pure waste (landfill, pyrolytic incineration);
- Heat Recovery (non-hazardous incineration optimised for energy recovery);
- Re-use or Closed-loop Recycling.

In order to lead these different tasks in absence of published data and interested stakeholders, six fans were bought (new products) or recovered (old of a few years). Since this is a very limited sample of all fans that are sold on the EU market, we made an attempt to take part of preceding tasks and to select representative fans, as defined in task 2. Main characteristics of the fans that will be used along task 4 are gathered in the table below.

N°	Type	Weight kg (no pack.)	Speeds number	Electrical P(W)	Diameter or height (cm)	Air flow	Rocking (H or V)	Options
1	TABLE FAN	3,006	3	50	Diam = 35 cm	N/A	H	no
2	TOWER FAN	4,234	3	40	H = 70 cm	N/A	H	TIMER
3	PEDESTAL FAN	3,669	3	50	Diam = 40 cm	1860	H	no
4	TABLE FAN	2,804	3	45	Diam = 30 cm	2040	H	no
5	BOX FAN	2,326	3	45	Diam = 30 cm	2400	H	TIMER
6	TOWER FAN	3,193	3	40	H = 70 cm	1440	H	TIMER + REMOTE + IONIZER

Table 4-1: List of fans for technical analysis

4.1 Production phase

After having been tested (see results in task 4.3 and 4.4), the 5 first fans were disassembled in order to establish the list of materials; results are reported hereafter.

4.1.1 Table fans

As can be seen on the picture below, the fan 1 was out of order, with a broken blade.

Figure 4-1: Disassembly photo of table fan 1

The list of spare parts and input to MEEuP Ecoreport tool is reported in the table below. There does not seem to be any category for lubricant which can be neglected anyway given the quantity.

Pos	MATERIALS Extraction & Production	Weight	Category	Material or Process
nr	Description of component	in g	Click &select	select Category first !
1	*Screw 30 mm*	4.9	3-Ferro	25-Stainless 18/8 coil
2	*Screw 12 mm*	3.4	3-Ferro	25-Stainless 18/8 coil
3	*Screw (Clamp)*	2.3	3-Ferro	25-Stainless 18/8 coil
4	*Screw (Black.)*	3.7	3-Ferro	25-Stainless 18/8 coil
5	*Plastic (Clamp)*	0.5	1-BlkPlastics	4-PP
6	*Screw*	1.7	3-Ferro	25-Stainless 18/8 coil
7	*Screw*	2.6	3-Ferro	25-Stainless 18/8 coil
8	*Screw*	1.1	3-Ferro	25-Stainless 18/8 coil
9	*Screw*	1.1	3-Ferro	25-Stainless 18/8 coil
10	*Blade support*	97.1	1-BlkPlastics	4-PP
11	*Slide casing of the support*	69.8	1-BlkPlastics	4-PP
12	*Motor cover*	92.5	1-BlkPlastics	4-PP
13	*Plastic connection*	12.7	1-BlkPlastics	4-PP
14	*Bearing lubricant*	1	??	??
15	*Ball bearing*	0.9	3-Ferro	23-Cast iron
16	*Spring*	0.2	3-Ferro	21-St sheet galv.
17	*White plastic*	14.6	1-BlkPlastics	10-ABS
18	*Black plastic*	7.3	1-BlkPlastics	10-ABS
19	*Ball bearing support*	34.0	4-Non-ferro	26-Al sheet/extrusion

20	*Blades*	157.7	1-BlkPlastics	10-ABS
21	*Ball bearing axe*	12.8	4-Non-ferro	30-Cu tube/sheet
22	*Elec. Supply and cables*	126.4	1-BlkPlastics	8-PVC
23	*Support*	670	4-Non-ferro	27-Al diecast
24	*Protective grids*	707	3-Ferro	25-Stainless 18/8 coil
25	*Support articulation*	92.6	1-BlkPlastics	4-PP
26	*Cu wires*	32	4-Non-ferro	29-Cu wire
27	*Motor block*	345	3-Ferro	21-St sheet galv.
28	*Plastic bag*	20	1-BlkPlastics	1-LDPE
29	*Cardboard*	550	7-Misc.	56-Cardboard
30	*Paper*	10	7-Misc.	57-Office paper
31	*Cu wires*	32	4-Non-ferro	29-Cu wire
32	*Motor shaft*	294	3-Ferro	21-St sheet galv.
33	*Motor superior part*	131	4-Non-ferro	27-Al diecast
34	*Cu motor winding*	34.5	4-Non-ferro	28-Cu winding wire

Table 4-2: List of materials of fan 1

Figure 4-2: Disassembly photo of table fan 4

Pos	MATERIALS Extraction & Production	Weight	Category	Material or Process
nr	Description of component	in g	Click &select	select Category first !
1	*blades*	154.0	1-BlkPlastics	10-ABS
2	*Support*	219.0	1-BlkPlastics	4-PP
3	*Motor cover*	170.0	1-BlkPlastics	4-PP
4	*Rotor wheel*	42.0	1-BlkPlastics	10-ABS
5	*switch*	5.4	1-BlkPlastics	10-ABS
6	*screw*	21.2	3-Ferro	25-Stainless 18/8 coil
7	*shock absorber*	9.8	3-Ferro	22-St tube/profile
8	*screw*	33.2	3-Ferro	25-Stainless 18/8 coil
9	*Plastics*	43.0	1-BlkPlastics	10-ABS
10	*Plastic plate*	5.8	1-BlkPlastics	10-ABS

11	*Motor block*	446.5	4-Non-ferro	**28-Cu winding wire**
12	*motor shaft*	294.0	3-Ferro	**21-St sheet galv.**
13	*motor sup part*	94.5	4-Non-ferro	**27-Al diecast**
14	*protection screw*	0.9	2-TecPlastics	**16-Flex PUR**
15	*White plastics*	11.8	1-BlkPlastics	**4-PP**
16	*lubricant*	2.0	??	**??**
17	*handful*	110.0	1-BlkPlastics	**10-ABS**
18	*Elec. Supply and cables*	112.0	1-BlkPlastics	**8-PVC**
19	*Brand name*	21.0	1-BlkPlastics	**10-ABS**
20	*Protection grid*	840.0	3-Ferro	**21-St sheet galv.**
21	*cintrage plastique*	70.0	1-BlkPlastics	**10-ABS**
22	*Copper*	28.0	4-Non-ferro	**29-Cu wire**
23	*Motor wiring*	36.5	4-Non-ferro	**28-Cu winding wire**
24	*Pack. Plastic bag*	20.0	1-BlkPlastics	**1-LDPE**
25	*Pack. Cardboard*	550.0	7-Misc.	**56-Cardboard**
26	*Pack. Paper*	10.0	7-Misc.	**57-Office paper**

Table 4-3: List of materials of fan 4

4.1.2 Box fan

Figure 4-3: Disassembly photo of fan 5 (Box Fan)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	*Screw*	4.4	3-Ferro	**25-Stainless 18/8 coil**
2	*Screw*	23.1	3-Ferro	**25-Stainless 18/8 coil**
3	*Screw*	2.7	3-Ferro	**25-Stainless 18/8 coil**
4	*Screw*	0.8	3-Ferro	**25-Stainless 18/8 coil**
5	*Screw*	2.2	3-Ferro	**25-Stainless 18/8 coil**
6	*Screw*	1.5	3-Ferro	**25-Stainless 18/8 coil**
7	*Screw*	9.1	3-Ferro	**25-Stainless 18/8 coil**

8	*Timer belt clamp*	0.6	1-BlkPlastics	**4-PP**
9	*Screw*	4.1	3-Ferro	**25-Stainless 18/8 coil**
10	*Screw*	0.8	3-Ferro	**25-Stainless 18/8 coil**
11	*Screw timer*	0.2	1-BlkPlastics	**1-LDPE**
12	*Screw timer*	0.2	1-BlkPlastics	**1-LDPE**
13	*Screw timer*	0.2	1-BlkPlastics	**1-LDPE**
14	*Screw timer*	0.3	1-BlkPlastics	**1-LDPE**
15	*Screw timer*	0.6	1-BlkPlastics	**1-LDPE**
16	*Screw synchroniser*	0.7	1-BlkPlastics	**1-LDPE**
17	*Screw synchroniser*	1.9	1-BlkPlastics	**1-LDPE**
18	*Screw synchroniser*	0.9	1-BlkPlastics	**1-LDPE**
19	*Screw synchroniser*	0.8	1-BlkPlastics	**1-LDPE**
20	*Screw synchroniser*	0.5	1-BlkPlastics	**1-LDPE**
21	*Screw synchroniser*	0.3	1-BlkPlastics	**1-LDPE**
22	*Screw*	0.6	3-Ferro	**25-Stainless 18/8 coil**
23	*blades*	125.4	1-BlkPlastics	**4-PP**
24	*Support table*	42.3	1-BlkPlastics	**4-PP**
25	*Support box*	445.0	1-BlkPlastics	**4-PP**
26	*Swith for speeds*	7.6	1-BlkPlastics	**10-ABS**
27	*balls speed switch*	0.5	3-Ferro	**23-Cast iron**
28	*Spring for switch*	0.1	3-Ferro	**21-St sheet galv.**
29	*Switch*	1.8	1-BlkPlastics	**4-PP**
30	*Switch*	3.0	1-BlkPlastics	**4-PP**
31	*Timer casing*	30.0	1-BlkPlastics	**4-PP**
32	*Switch rocking*	1.0	1-BlkPlastics	**10-ABS**
33	*switch timer*	7.5	1-BlkPlastics	**10-ABS**
34	*support switch timer*	6.8	1-BlkPlastics	**4-PP**
35	*spring switch timer*	0.2	3-Ferro	**21-St sheet galv.**
36	*Timer plate*	1.0	4-Non-ferro	**26-Al sheet/extrusion**
37	*timer support switch*	2.1	1-BlkPlastics	**4-PP**
38	*Motor rope*	1.8		
39	*Attache moteur*	3.0	1-BlkPlastics	**4-PP**
40	*Capacity*	16.8	1-BlkPlastics	**4-PP**
41				
Pos nr	**MATERIALS Extraction & Production Description of component**	**Weight in g**	**Category Click &select**	**Material or Process select Category first !**
42	*Plug*	60.0	1-BlkPlastics	**8-PVC**
43	*Elec cable*	4.8	4-Non-ferro	**29-Cu wire**
44	*Plastic conn.*	4.3	6-Electronics	**45-slots / ext. ports**
45	*Collar clamp*	0.2	1-BlkPlastics	**4-PP**
46	*Switch motor*	0.1	1-BlkPlastics	**10-ABS**
47	*Motor protection black*	167.3	3-Ferro	**21-St sheet galv.**
48	*Motor shaft*	171.8	3-Ferro	**23-Cast iron**
49	*Motor synchronous*	67.8	3-Ferro	**21-St sheet galv.**
50	*bloc moteur*	363.8	3-Ferro	**21-St sheet galv.**
51	*Rondelle moteur*	0.4	3-Ferro	**25-Stainless 18/8 coil**
52	*Plastics blue*	244.3	1-BlkPlastics	**10-ABS**

53	***Plastics white***	428.9	1-BlkPlastics	**10-ABS**
54	***Plastic bag***	20.0	1-BlkPlastics	**1-LDPE**
55	***Cardboard***	550.0	7-Misc.	**56-Cardboard**
56	***paper***	10.0	7-Misc.	**57-Office paper**
57	***copper***	22.0	4-Non-ferro	**29-Cu wire**
58	***motor wiring***	28.5	4-Non-ferro	**28-Cu winding wire**

Table 4-4: List of materials of fan 5

4.1.3 Pedestal fan

We tend to assimilate the pedestal fan and the table fan in this study, taking into account the material needed to manufacture the column, usually steel. The weight of the added column has been found statistically to be 1340 grams, with the following average weights for the 3 categories of fans. We observed that pedestal columns are getting heavier

4.1.4 Tower fan

Figure 4-4: Disassembly photo of fan 2 (Tower Fan)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	***Elec. Control***	73,4	4-Non-ferro	**30-Cu tube/sheet**
2	***Protection switch***	55,5	1-BlkPlastics	**4-PP**
3	***Timer switch***	7,8	1-BlkPlastics	**4-PP**
4	***Al. Plate***	346,0	4-Non-ferro	**26-Al sheet/extrusion**
5	***Plastic rocking arm***	76,7	1-BlkPlastics	**4-PP**
6	***Rocking motor***	156,3	3-Ferro	**21-St sheet galv.**
7	***principal motor shaft***	199,6	3-Ferro	**23-Cast iron**
8	***Plastic piece rocking***	9,3	1-BlkPlastics	**4-PP**
9	***motor plate***	96,2	4-Non-ferro	**26-Al sheet/extrusion**
10	***secundary motor shaft***	57,1	3-Ferro	**23-Cast iron**
11	***Bearing ball***	11,2	3-Ferro	**23-Cast iron**
12	***Casing timer***	30,0	1-BlkPlastics	**4-PP**

13	***screw timer***	1,5	1-BlkPlastics	**1-LDPE**
14	***Plastic timer***	8,2	1-BlkPlastics	**4-PP**
15	***screw***	77,1	3-Ferro	**25-Stainless 18/8 coil**
16	***Motor lower part***	367,1	3-Ferro	**21-St sheet galv.**
17	***Motor higher part***	298,6	3-Ferro	**21-St sheet galv.**
18	***plug***	230,0	1-BlkPlastics	**8-PVC**
19	***Plastics misc***	5,1	1-BlkPlastics	**4-PP**
20	***Fan wheel***	441,4	1-BlkPlastics	**4-PP**
21	***Casings***	1320,0	1-BlkPlastics	**4-PP**
22	***Tower support***	254,0	1-BlkPlastics	**4-PP**
23	***polystyrene***	85,0	1-BlkPlastics	**5-PS**
24	***Cardboard***	712,0	7-Misc.	**56-Cardboard**
25	***paper***	10,0	7-Misc.	**57-Office paper**
26	***copper***	57,0	4-Non-ferro	**29-Cu wire**
27	***Copper wiring***	32,0	4-Non-ferro	**28-Cu winding wire**

Table 4-5: List of materials of fan 5

4.1.5 Conclusion on material input

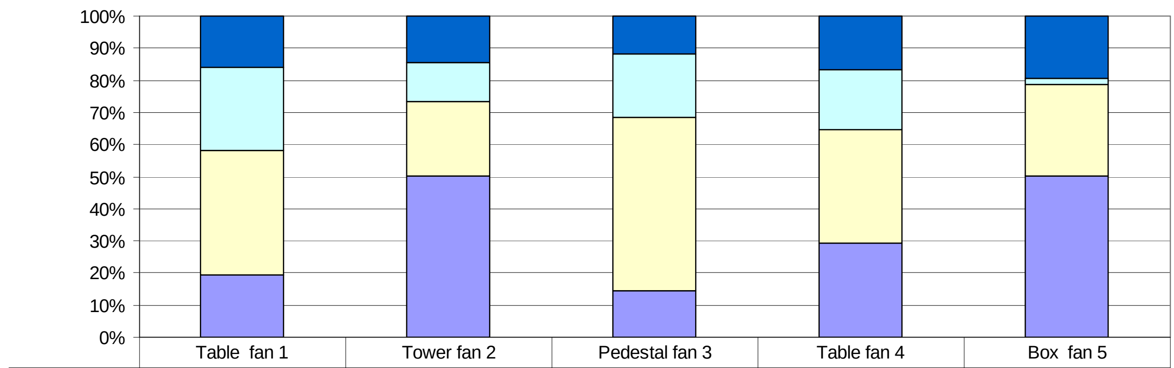


	Table fan 1	Tower fan 2	Pedestal fan 3	Table fan 4	Box fan 5
Misc.	16%	14%	12%	17%	19%
Electronics	0%	0%	0%	0%	0%
Coating	0%	0%	0%	0%	0%
Non-ferro	26%	12%	20%	19%	2%
Ferro	39%	23%	54%	35%	28%
TecPlastics	0%	0%	0%	0%	0%
Bulk Plastics	20%	50%	15%	29%	50%

Figure 4-5: Comparison of material contents of the 5 fans dismantled

Table fans 1 and 4 have similar overall compositions. For fan 4, the part of plastics increased and this is a common tendency to replace metals by plastics (for blades, for protection grids, for support …). The extreme situation is the box fan whose non ferrous metal content has been reduced to 0, excluding the motor. The more recent tower fan was not dismantled. Nevertheless, the evolution is similar, more plastics and less metal. In the latest evolution of table and tower fans, only metals for the motor and for electric and motor wiring remain.

Miscellaneous components translate the packaging cardboard and paper and its relative weight varies in opposition with the total weight of the product, packaging materials and weight being about similar for all products.

For the time being, the production phase seems to take place in Chinese light industry, with around one hundred manufacturing companies[11]. It is difficult to know if the ratios that are applied to the BOM in the MEEuP Ecoreport apply correctly to such conditions.

4.2 Distribution phase

Distribution of comfort fans seems to have special features, since they all come from one country but are distributed by numerous channels. 100 % is imported whereas in the hypothesis of the MEEuP, the hypothesis is that transportation only includes 50 % of abroad import with long distance air (10 %) or sea (90 %) freight (MEEuP):
"This includes final assembly, delivery to EU distribution centre(s) and warehouses (heating and lighting as row 53) either by intra-EU trucking/rail (50%), sea-freight + EU trucking/rail (45%) or air-freight + EU trucking/rail (5%). Trucking-rail ratio for ICT&CE products assumed 90:10. Distances: 1000 km intra-EU trucking/rail, 12,000 km sea-freight, 10,000 km air-freight. Final delivery to whole-seller or central retail warehouse: 500 km in medium-sized truck."

Based on (ADEME, 2005), the above ratios indicate that air transportation is responsible for about 70 % of the emissions of GHG for the transportation figures are caused by the 5 % of air transportation. Long distance freight of comfort fans is likely to be mainly see-freight. The absolute emission value depends on the share of transportation by plane, and less on the relative shares of truck or ship freights. As a consequence, we will not change these values, since part of importation made by plane versus ship is not known.

For the average sizes of fans in our database, packaging volumes are as follows:

Table fan: 0,06 m3
Pedestal fan: 0,15 m3
Tower fan: 0,08 m3
Box fan: 0,06 m3

4.3 Use phase (product)

Since the essential use phase impact is energy, we have to determine average energy efficiency, and number of hours of operation. Since there are usually various speeds, the number of hours of operations should be weighted for that, leading to an equivalent full speed number.

4.3.1 Analysis of products catalogue data

Is there an average performance? For ceiling fan Energy Star gives a wide data base of performance for products sold in the US, with no proof that it is representative for EU. Also ceiling fans are not sold largely in Europe. We are not aware of any other existing data basis of performance of fans in the EU.

The Energy Star data basis (limited to US ceiling fans) contains the following information:
- Manufacturer Name
- Brand Name
- Model Name
- Model Number
- Retailer/ SKU Number
- Efficiency (CFM/Watt) – Low speed
- Efficiency (CFM/Watt) – Medium speed
- Efficiency (CFM/Watt) – High speed

[11] We find 87 active manufacturers selling through alibaba.com, for instance

- Motor Warranty (years)
- Components Warranty (Years)
- Date Available on Market

For the EU we have used our own data basis from internet and store surveys (two hundreds of entries[12]) for the products which are really sold in Europe, with the following items:

- Trade mark
- EU distributor
- Manufacturer
- Year
- Reference
- Type
- Speeds number
- Electrical P (W)
- Diameter (cm)
- Air velocity
- Air flow
- Oscillating Horizontally?
- Oscillating Vertically?
- Other options
- Price

To characterise energy performance the first idea is to correlate Wattage and Air flow. We admit that air flow reported has been measured according to IEC 60879 which is never said. The correlation hereunder is for all types.

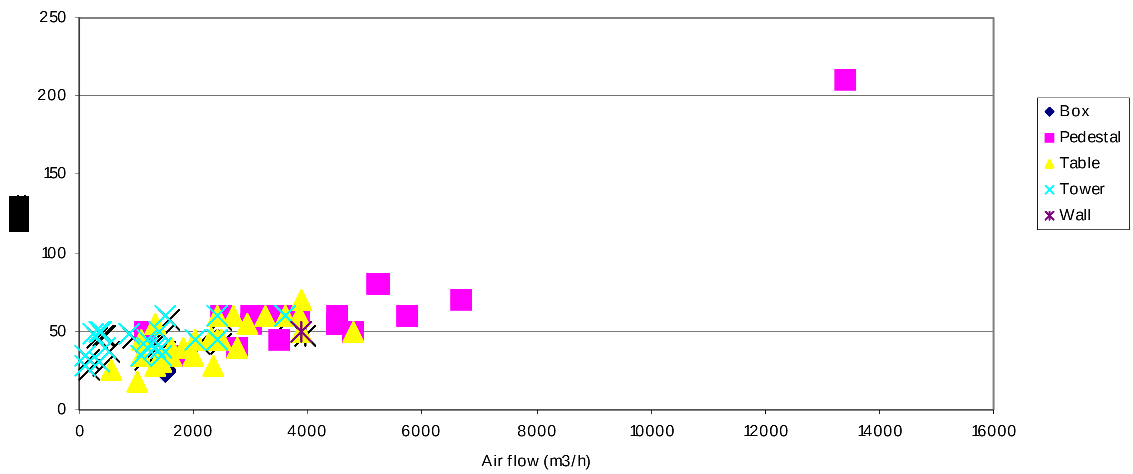


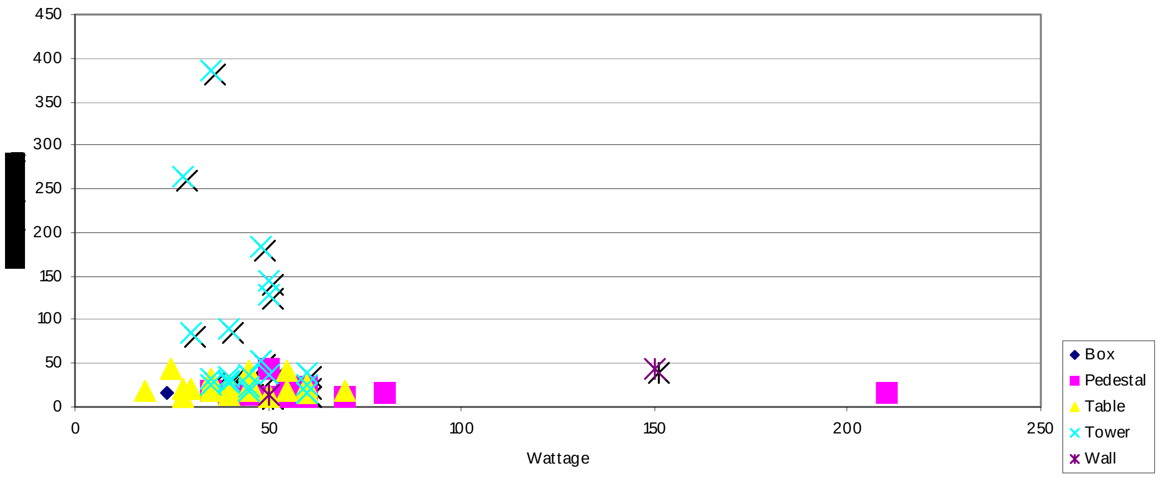
Figure 4-6: Correlation on data base (Wattage (W) versus Air flow (m3/h))

Regression shows a constant term in electricity consumption around 20W and an increase with flow. Tower fans are not better than table fans for small flows, but may have a different impact on end user for the same flow value due to the concentration of the flow in some kind of "jet".

[12] 26 brands with exactly 185 distinct models

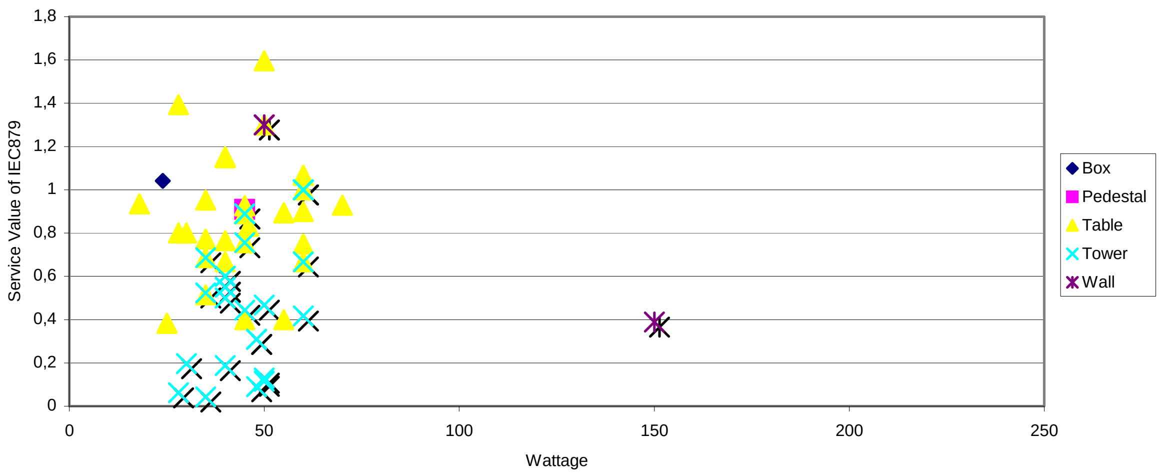
The efficiency, if defined as SFP=Pelec/Flow varies largely: 10.5 to 68.0 mW/(m3/h), excluding tower fans which are worse. Ceiling fans within Energy Star (not perfectly comparable) reach 3.8 to 7.9 mW/(m3/h), which shows anyway a large margin for improvement. The tower fans display the worst efficiency in general.

Figure 4-7: Use of traditional SFP (SFP (W/(m3/h)) versus Wattage (W))



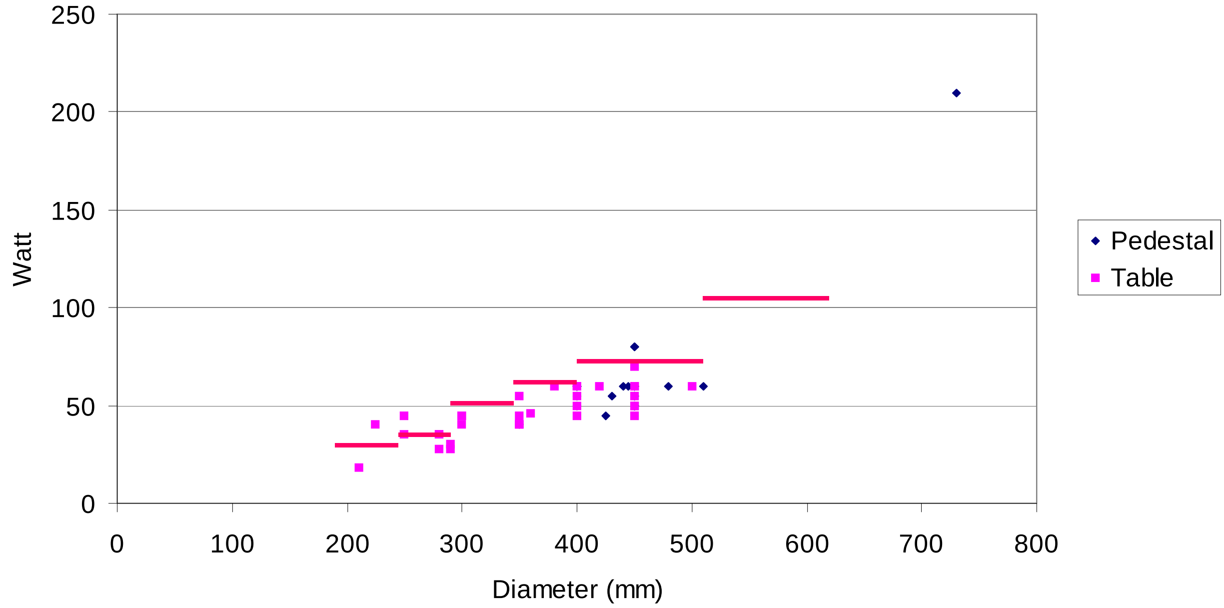
If we take now as a definition of efficiency the Service value given in IEC 879 (flow in m3/min divided by Pelec in Watt), we obtain the same magnitude of variations. The Tower fans appear for what they are: far less efficient to generate a total given flow, but their flow is different, namely like a directional jet.

Figure 4-8: Use of IEC 879 service value



We can also relate the flow with the diameter, like in the Chinese standard. The fans are generally compliant (in declaration, not in fact) with the Chinese efficiency standard, the country where they come from. Here under the line (Chinese efficiency standard) and the points (EU market with available data):

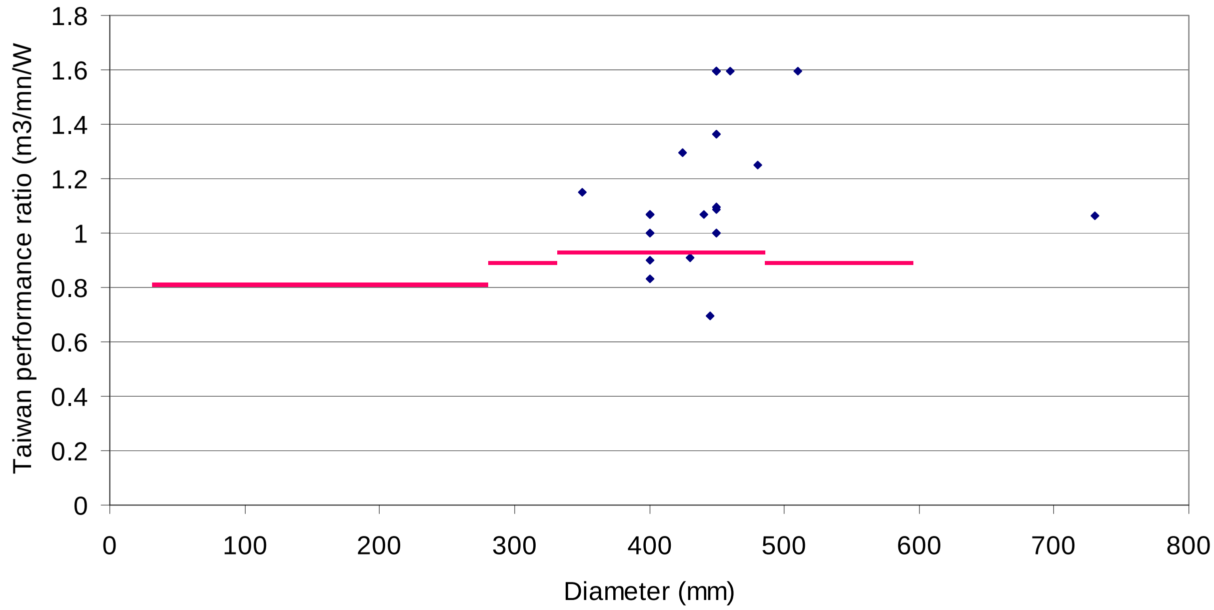
Figure 4-9: Use of Chinese standard



We can understand the danger of the Chinese standard presentation as it can be understood as a design guide: if I want to make a 40 cm fan, I select a 60 W motor without deciding really on the flows and velocities, and I am compliant.

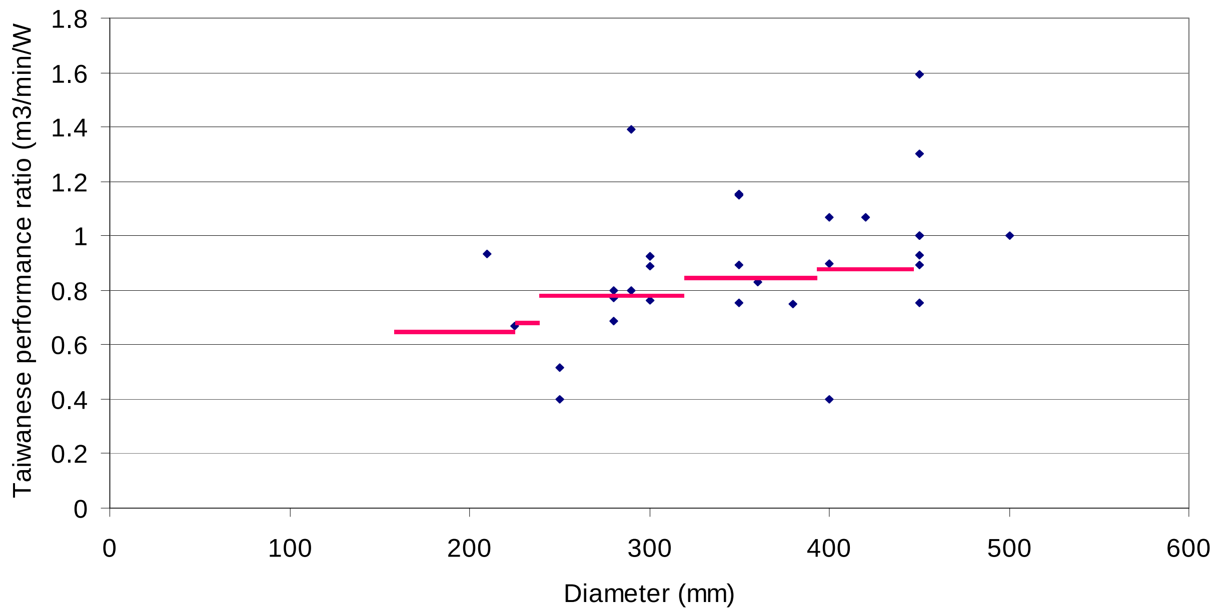
The Taiwanese standard uses the ratio between the wattage and the flow. Performance of pedestal and table fans and requirements are presented in the two following figures: not all EU fans comply.

Figure 4-10: Comparison of EU pedestal fans performances and of the Taiwanese requirements



The figure hereunder gives the comparison of EU table fans with the Taiwanese standard.

Figure 4-11: Comparison of EU table fans performances and of the Taiwanese requirements



Some fans manufactured in China do not comply apparently with one of the Chinese standards. “Apparently” because there is no mention of any testing standard and laboratory, and the advertising material is made clearly by non technical people who can easily make an error.

At the moment **standby** data for **ceiling fans** are available thanks to www.energyrating.gov.au. This doesn’t correspond to our EU fans. Over the 38 measurement made, 4 had a remote controller with standby power always lower than 1,3 W. The other had all off mode power inferior to 1 W.

We have also measured ourselves standby and off mode power for a typical tower fan ; tower fan are now about all supplied with remote control. Standby was of 2 W with 0 W off mode.

About the noise, the manufacturers directory indicate values more or less uniformly distributed between 40 and 50 dBA. One claims to be under 40 dBA but does not give a value. No testing standard is mentioned.

4.3.2 Experimental results

Electric power

The power consumption of the 6 tested fans have been measured (uncertainty of measurement of 0.6 %) for the 3 different speeds of operation, with and without rocking of the fan (horizontal rocking).

		FAN 1 *Table*	**FAN 2** *Tower*	**FAN 3** *Pedestal*	**FAN 4** *Table*	**FAN 5** *Box*	**FAN 6** *Tower*
Manufacturer data		**50**	**40**	**50**	**45**	**45**	**40**
		P (W)	***P (W)***	***P (W)***	***P (W)***	***P (W)***	***P (W)***
Without rocking	***Speed 1***	**40,0**	**31,7**	**40,5**	**25,5**	**39,1**	**41,4**
	Speed 2	**43,5**	**35,4**	**43,2**	**29,7**	**43,0**	**44,4**

	Speed 3	48,3	41,4	48,3	35,0	48,3	45,3
With rocking	Speed 1	40,3	32,2	40,5	25,5	40,9	42,1
	Speed 2	44,2	36,6	44,4	29,7	45,3	45,3
	Speed 3	49,7	44,2	49,7	35,0	51,1	47,4

Table 4-6: Power consumption of the 6 tested fans in the 3 speeds of operation, with and without oscillation

Measured power (highest speed without oscillation) ranges between 77 % and 113 % of declared value. Power reduces only slightly with flow reduction.

For tower and box fans, a second motor enables the horizontal oscillation while for other types, rocking are ensured by a second axe powered by the same motor. Power consumption without rocking is up to 5 % lower, this percentage being lower at lower speed.

Measurement of air flow

Measurement of air flows has been realized in good agreement with the test standard IEC 60879 for table and box fans. However, since measurement was not made with a dedicated test bench in an accredited laboratory, results give only indicative values. For the table and the box fans, measured air flow rates were found much lower than indicated by the technical data sheet of the equipment (see table below). This methodology applied in the conditions available for testing is estimated to conduct to more or less 20 % uncertainty.

Concerning tower fans, there is no indication how to measure the air flow since this type of fan was not on the market in 1986, date of the publishing of the present IEC standard. Let’s indicate that the flow given by a tower unit and the flow given by a circular unit (table/pedestal) have not the same characteristics. The first one is limited to some kind of “jet” while the other one is larger but spread over a large volume, as shown by our measurements.
The measurement was made following the general indications of the IEC standard but on a cylinder portion of an angle of 90 °, and at different points of the height of the tower, in order to measure the complete air flow rate. This methodology applied in the conditions available for testing is estimated to conduct to more or less 20 % uncertainty.

In both cases, measurements were made with a hot wire anemometer, in order to measure stabilized air flow and avoid swirl effects that could false the measurements.

Results are gathered in the table below.

Air flow rates in m^3/h		FAN 4	FAN 5	FAN 6
		Table	*Box*	*Tower*
Declared air flow rate		2040	2400	1440
Measured air flow rate	**Speed 3**	491,5	643,5	1596,5
	Speed 2	424,1	622,7	1091,4
	Speed 1	202,2	425,5	687,0

Table 4-7: Measured air flow rates at the 3 speeds of operation for 3 types of fans, and declared nominal flow rate

It appears that the service value indicated on the technical data sheets supplied with the product are far from being respected for table and box fan while the order of magnitude is in good agreement for the tower fan tested. The tower fan finally displays a higher flow than the equipment which is rated as far more powerful in the documentation.

Efficiency

The service value required by the IEC standard, a reasonable Energy Efficiency Index, is reported in the table below for the 3 fans at their different speeds.

	FAN 4	FAN 5	FAN 6
Index	**Table**	**Box**	**Tower**
Declared	0,76	0,89	0,60
Measured in m^3/min/W			
Fan speed 3	0,23	0,22	0,59
Fan speed 2	0,24	0,24	0,41
Fan speed 1	0,13	0,18	0,28

Table 4-8: Measured service value at the 3 speeds of operation for 3 types of fans, and declared nominal service value

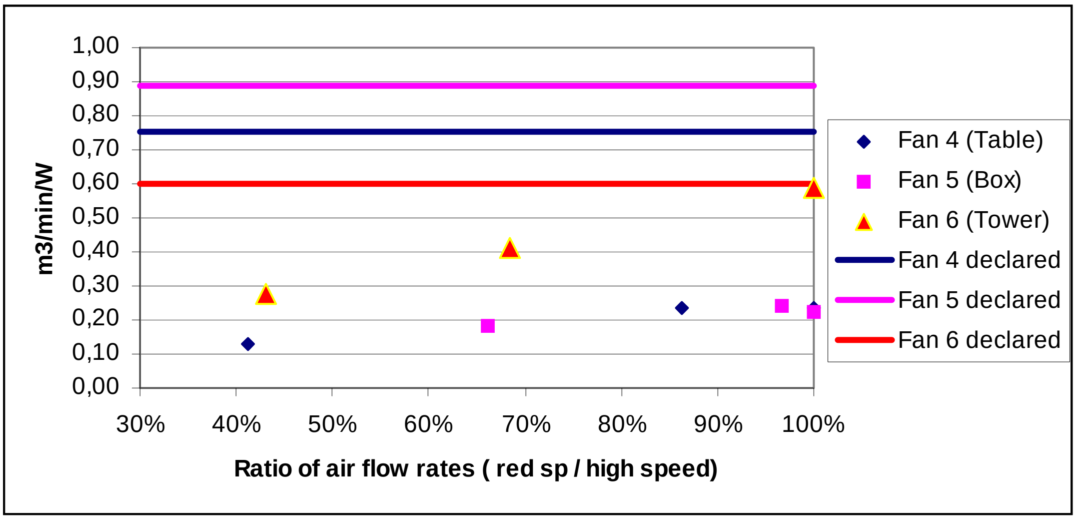


Figure 4-12: Measured service value at the 3 speeds of operation for 3 types of fans, and declared nominal service value

Thus, measurements made appear that both table fans 4 and 5 do not pass the minimum requirement of the Taiwanese MEPS despite conform declared values. A factor 3 to 4 between service value declared and realized is observed for both fans. This is mainly due to the very important error on the flow rate while the power consumption is in good agreement with declared values. In addition, efficiency at reduced speed is not maintained and is cut by 50 % at 40 % load. It is also interesting to see that both fans, box and table fan have exactly the same power / flow rate line – they use the same motor.

Only the tower fan has a declared value compatible with the measured value. It has been impossible to decide is this is due to wrong declarations, use of a national testing standard, or a test made with no standard. There is an unproven hypothesis that the testing of fans with a duct (like in the EPA test) leads to that order of magnitude of difference with the International Standard (3 to 4 times more flow). The indications on the market could be cleaned from potential false declarations if manufacturers would refer to IEC standard. None of them does.

Efficiency at reduced air flow rate also falls by 50 % as compared to full speed for about 40 % of high speed air flow rate. Given that the weighted average number of hours is about 320 hours for EU and that it operates at about 50 % air flow rate in average, it can be deduced that as compared to nominal index, the energy consumption is to be multiplied by the degradation of SFP at 50 % air flow rate, ie 50 % efficiency.

Translated in a corrected number of full air flow equivalent, this simply gives the weighted average number of full load equivalent hours, ie **320 hours**. This number of hours will be kept to translate the energy consumption of comfort fans.

Assuming that comfort fans are used mainly during summer months of July and August in the EU, this leads to 1440 hours with fans plugged in for 1440 – 320 = **1120 hours for stand-by** (fans equipped with a remote controller), while they remain unplugged (O W off-mode) outside of this period.

4.4 Use phase (system)

The only system interaction identified regards ceiling fans and heating and cooling equipment, that could modify the number of hours of use of ceiling fans. Without further information on the quantification of this effect and having in mind the absence of residential ceiling fans in the EU, we will keep the same number of operating hours for ceiling fans.

4.5 End-of-life phase

This type of small appliance is likely to enter well into the post WEEE circuits. As a default hypothesis, we will use WEEE targets to assume the end of life fate of comfort fans, as required by the MEEuP.

Task 4 summary

Material content of comfort fans vary mainly with the share of plastics it contains.

Despite these products are all imported from Far East, the analysis of distribution environmental factors shows it is not necessary to change these parameters.

The fans used in Europe are different in function and performance from the ceiling fans in the US.
Their performance can be studied with various data presentations, some of them being related with Asian standards.

- Watt for a certain flow, for a certain diameter (China and Taiwan)
- SFP (specific wattage per unit flow) for a certain size or Wattage – US standard
- “Service value” of IEC 879, flow generated per Watt, as a function of size or Wattage – the international standard, adequate for our purpose.

In the catalog of manufacturers, the tower fans appear to be less efficient to generate air flow while experimental test carried out to measure SFP for a certain number of fans showed that on the contrary they were more efficient than the table and box fan tested, which by the way had performances far below declared values concerning air flow rates. Based on the declared value, most fans are compliant with Chinese and Taiwanese standards but not all. Based on the limited experimental performance assessment led within the project, there is a significant margin for performance improvement and a lot of non compliance of producing countries with their own standards.

Most fans have 3 speeds, which are practically used. Efficiency falls rapidly with air flow reduction, as low as 50 % of nominal efficiency at about 40 % air flow rate.

Equivalent number of hours of full load operation is 320 hours and also 1120 hours of stand-by operation for units with a remote controller.

5 DEFINITION OF BASE-CASE

5.1 Product-specific inputs

As shown in Figure 2-3, the sales are largely dominated by table, pedestal and tower fans that represent 91 % of sold models. These 3 categories will be kept to define the base cases.

We keep as base cases 50 W for table/pedestal fans and 40 W for tower fans, that are the average electric power values in our database of products. Due to the uncertainties about declared and measured flow values, we will admit without total confidence a service value of 0.22 (m3/min)/W and 0.60(m3/min)/W.

The average weight for the products, without their packaging are as follows:
- Tower: 4000 grams
- Table fan average weight: 3460 grams
- Pedestal fan average weight: 4700 grams

Packaged products have the following volumes:
- 0.06 m3
- 0.15 m3
- 0.08 m3

The material composition for the 3 product types, including the packaging, is recalled in the table below:

	PEDESTAL	TABLE	TOWER
Stainless Steel	78,3	78,3	76,0
Cast iron	1000,0	0,0	264,1
Copper	664,3	664,3	160,1
Steel	1383,6	1383,6	646,5
Plastics PP	488,0	488,0	2190,4
Plastics ABS	524,9	524,9	0,0
Plastics LDPE	24,4	24,4	0,0
Electronics	0,0	0,0	0,0
Cardboard	700,0	560,4	596,0
Office paper	10,2	10,2	8,4
Al die cast	359,8	159,8	436,0
Plastics PVC	136,6	136,6	226,8
Total weight (g)	5370,2	4030,6	4604,3

Table 5-1: Material composition of base cases

Concerning the use phase, the average number of equivalent hours at rated air flow hours is 320; for the tower fan, the only category identified with a remote controller, 1120 hours of stand-by with 2 W of electric power are also accounted for.

This leads to the following energy consumption for the 3 base cases:
- table fan and pedestal: 16 kWh (active mode)
- tower fan: 15.7 kWh = 12.8 kWh (active mode) + 2.9 kWh (stand-by mode)

Primary scrap production during sheet metal manufacturing (avg. EU) is kept at the default value of 25 %.

Concerning reuse and recycling, in absence of more information, default values are kept.

5.2 Base-Case Environmental Impact Assessment.

Using the VHK EuP EcoReport indicate the environmental impact analysis, specifying:
Emission/resources categories as mentioned in the MEEUP
Report for:
- *Raw Materials Use and Manufacturing;*
- *Distribution;*
- *Use;*
- *and End-of-Life Phase.*

and distinguishing for the Use phase between the Standard Base-Case and the Real-life Base-Case. Furthermore, if more than one type of resource is used in the Use phase, make a split-up between resources and their individual impacts.

The hypothesis of the base cases as specified above are kept for the base case environmental impact assessment. Real life and standard number of hours are equivalent according to our findings of task 4.3.

Table fan

Table . Life Cycle Impact (per unit) of Products

Nr	Life cycle Impact per product:	Date	Author
0	Products	0	vhk

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			**1174**			1057	117	**1174**	**0**
2 TecPlastics	g			**0**			0	0	**0**	**0**
3 Ferro	g			**1462**			73	1389	**1462**	**0**
4 Non-ferro	g			**824**			41	783	**824**	**0**
5 Coating	g			**0**			0	0	**0**	**0**
6 Electronics	g			**0**			0	0	**0**	**0**
7 Misc.	g			**571**			29	542	**571**	**0**
Total weight	g			**4031**			1199	2831	**4031**	**0**
								see note!		
Other Resources & Waste							debet	credit		
8 Total Energy (GER)	MJ	249	75	**325**	**263**	**1683**	86	63	**22**	**2293**
9 of which, electricity (in primary MJ)	MJ	14	45	**59**	**0**	**1681**	0	0	**0**	**1739**
10 Water (process)	ltr	19	1	**20**	**0**	**112**	0	0	**0**	**132**
11 Water (cooling)	ltr	116	20	**137**	**0**	**4481**	0	2	**-2**	**4615**
12 Waste, non-haz./ landfill	g	15977	289	**16265**	**153**	**2111**	247	2	**246**	**18775**
13 Waste, hazardous/ incinerated	g	8	0	**8**	**3**	**39**	1057	0	**1056**	**1107**
Emissions (Air)										
14 Greenhouse Gases in GWP100	kg CO2 eq.	13	4	**17**	**20**	**73**	6	4	**2**	**113**
15 Ozone Depletion, emissions	mg R-11 eq				negligible					
16 Acidification, emissions	g SO2 eq.	226	18	**245**	**66**	**435**	13	6	**7**	**753**
17 Volatile Organic Compounds (VOC)	g	0	0	**0**	**3**	**1**	0	0	**0**	**4**
18 Persistent Organic Pollutants (POP)	ng i-Teq	44	4	**48**	**1**	**11**	2	0	**2**	**62**
19 Heavy Metals	mg Ni eq.	53	9	**62**	**8**	**29**	23	0	**23**	**123**
PAHs	mg Ni eq.	8	0	**8**	**6**	**3**	0	0	**0**	**17**
20 Particulate Matter (PM, dust)	g	9	3	**12**	**67**	**9**	111	0	**111**	**200**
Emissions (Water)										
21 Heavy Metals	mg Hg/20	77	0	**77**	**0**	**12**	7	0	**7**	**96**
22 Eutrophication	g PO4	1	0	**1**	**0**	**0**	0	0	**0**	**1**
23 Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

Table 5-2: Environmental impact of table fan base case

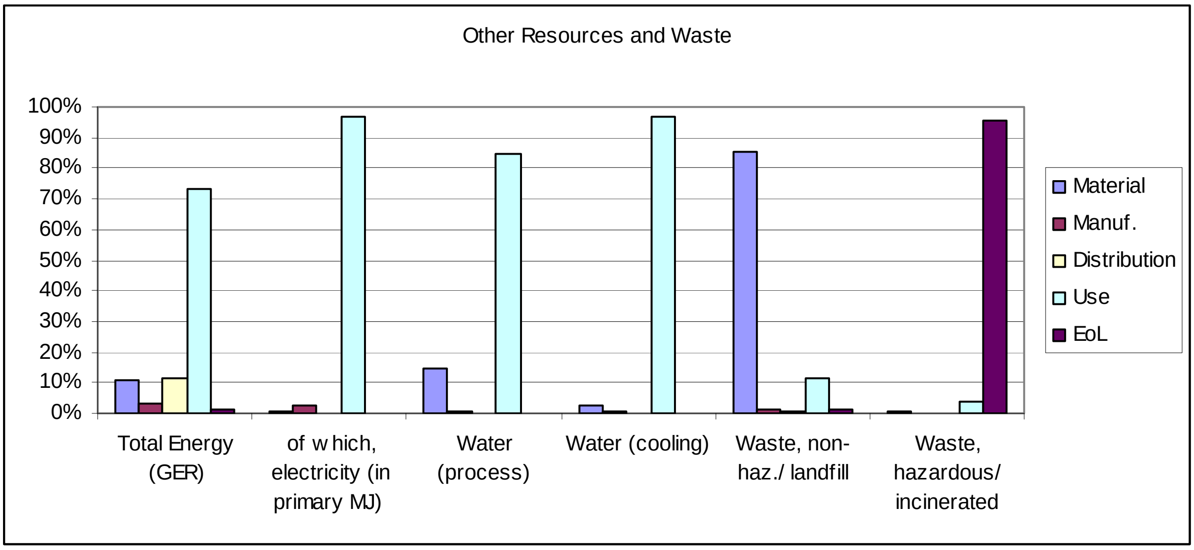


Figure 5-1: Environmental impact of table fan base case, other resources and waste

Over the life cycle of the product, about 70 % of the energy consumed and more than 90 % of the electricity are due to the use phase while waste are mainly the consequence of the disposal and incineration of the raw materials used to make the product.

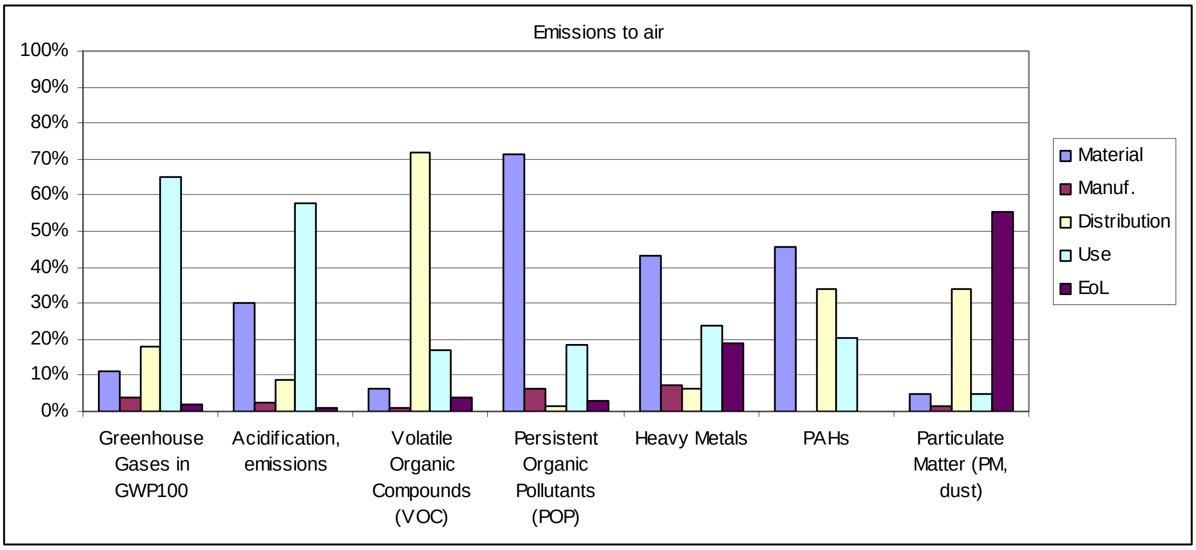


Figure 5-2: Environmental impact of table fan base case, emissions to air

Concerning emissions to air, the rationale is similar for GHG emissions and acidification: the energy consumption during the use phase is preponderant. Concerning VOC emissions, transportation is the major responsible while material used is of primary importance for POP, heavy metals and PAHs. Particulate matters (PM, dust) is primarily linked to incineration and distribution.

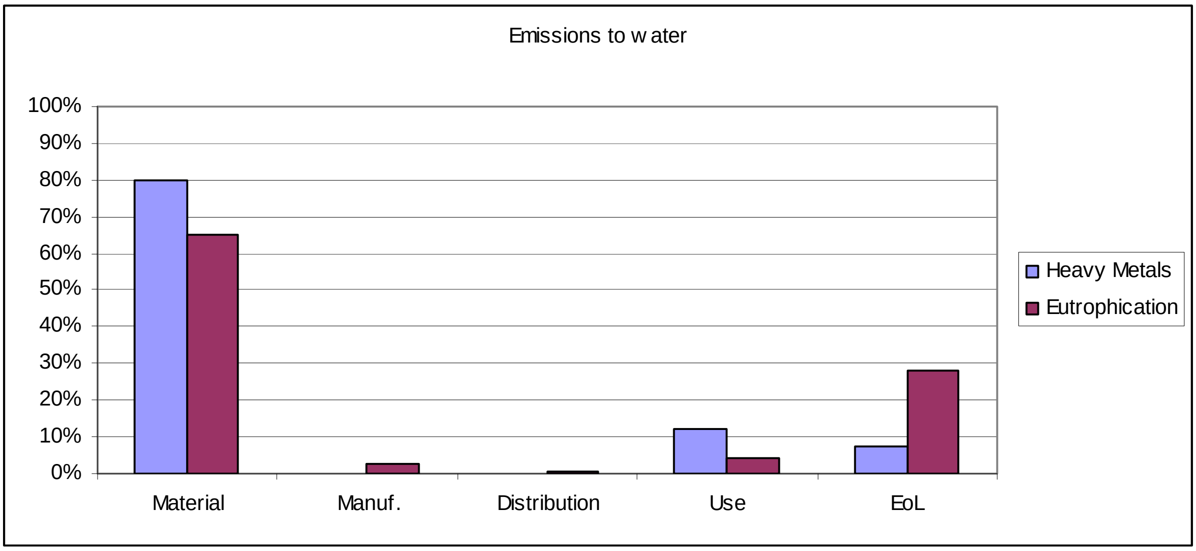


Figure 5-3: Environmental impact of table fan base case, emissions to water

Emissions to water are mainly the consequence of the material used for the product.

As a conclusion, it can be said that even if electricity consumption is of major importance over the product total life cycle, other product life phases cannot be neglected, particularly the choice of materials used in making the product.

Results for pedestal and tower fans are broadly similar despite variations of the ratio of metals to plastics, that mainly affect the impact of the production and of the end-of-life phases in the overall environmental performance of the product.

Pedestal fan

Table . Life Cycle Impact (per unit) of Products

Nr	Life cycle Impact per product:						Date		Author		
0	Products						0		vhk		
	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			**1174**			1057	117	**1174**	**0**
2	TecPlastics	g			**0**			0	0	**0**	**0**
3	Ferro	g			**2462**			123	2339	**2462**	**0**
4	Non-ferro	g			**1024**			51	973	**1024**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**0**			0	0	**0**	**0**
7	Misc.	g			**710**			36	675	**710**	**0**
	Total weight	g			**5370**			1266	4104	**5370**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	274	79	**353**	**580**	**1684**	90	65	**25**	**2641**
9	of which, electricity (in primary MJ)	MJ	15	47	**61**	**0**	**1681**	0	0	**0**	**1742**
10	Water (process)	ltr	22	1	**22**	**0**	**112**	0	0	**0**	**134**
11	Water (cooling)	ltr	120	21	**141**	**0**	**4481**	0	2	**-2**	**4620**
12	Waste, non-haz./ landfill	g	16449	300	**16749**	**306**	**2115**	330	2	**328**	**19498**
13	Waste, hazardous/ incinerated	g	8	0	**8**	**6**	**39**	1057	0	**1056**	**1110**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	14	4	**19**	**44**	**74**	7	5	**2**	**139**
15	Ozone Depletion, emissions	mg R-11 eq.	negligible								
16	Acidification, emissions	g SO2 eq.	233	19	**252**	**148**	**435**	13	6	**8**	**843**
17	Volatile Organic Compounds (VOC)	g	0	0	**0**	**7**	**1**	0	0	**0**	**8**
18	Persistent Organic Pollutants (POP)	ng i-Teq	57	4	**61**	**2**	**12**	2	0	**2**	**77**
19	Heavy Metals	mg Ni eq.	55	9	**65**	**16**	**29**	25	0	**25**	**134**
	PAHs	mg Ni eq.	11	0	**11**	**10**	**3**	0	0	**0**	**25**
20	Particulate Matter (PM, dust)	g	24	3	**27**	**168**	**10**	117	0	**117**	**321**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	79	0	**79**	**0**	**12**	8	0	**8**	**98**
22	Eutrophication	g PO4	1	0	**1**	**0**	**0**	0	0	**0**	**1**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

Table 5-3: Environmental impact of pedestal fan base case

Tower fan

Table . Life Cycle Impact (per unit) of Products

Nr	Life cycle Impact per product:	Date	Author
0	Products	0	vhk

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			**2417**			2175	242	**2417**	**0**
2	TecPlastics	g			**0**			0	0	**0**	**0**
3	Ferro	g			**987**			49	937	**987**	**0**
4	Non-ferro	g			**596**			30	566	**596**	**0**
5	Coating	g			**0**			0	0	**0**	**0**
6	Electronics	g			**0**			0	0	**0**	**0**
7	Misc.	g			**604**			30	574	**604**	**0**
	Total weight	g			**4604**			2285	2320	**4604**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	261	115	**376**	**333**	**1583**	164	130	**34**	**2326**
9	of which, electricity (in primary MJ)	MJ	22	69	**91**	**0**	**1580**	0	1	**-1**	**1670**
10	Water (process)	ltr	24	1	**25**	**0**	**106**	0	1	**-1**	**130**
11	Water (cooling)	ltr	103	32	**135**	**0**	**4213**	0	5	**-5**	**4343**
12	Waste, non-haz./ landfill	g	4912	387	**5299**	**187**	**1884**	283	4	**279**	**7650**
13	Waste, hazardous/ incinerated	g	11	0	**11**	**4**	**36**	2175	1	**2175**	**2226**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	10	6	**17**	**26**	**69**	12	9	**3**	**115**
15	Ozone Depletion, emissions	mg R-11 eq	negligible								
16	Acidification, emissions	g SO2 eq.	80	28	**108**	**85**	**408**	25	12	**13**	**613**
17	Volatile Organic Compounds (VOC)	g	0	0	**0**	**4**	**1**	0	0	**0**	**5**
18	Persistent Organic Pollutants (POP)	ng i-Teq	34	2	**36**	**1**	**11**	2	0	**2**	**50**
19	Heavy Metals	mg Ni eq.	23	5	**28**	**10**	**27**	44	0	**44**	**109**
	PAHs	mg Ni eq.	9	0	**9**	**7**	**3**	0	0	**0**	**19**
20	Particulate Matter (PM, dust)	g	11	4	**15**	**90**	**9**	212	0	**212**	**325**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	28	0	**28**	**0**	**10**	14	0	**14**	**52**
22	Eutrophication	g PO4	1	0	**1**	**0**	**0**	1	0	**1**	**2**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

Table 5-4: Environmental impact of tower fan base case

5.3 Base-Case Life Cycle Costs

Combining the results from tasks 2 and 3 define — for the Standard and Real-Life Base-Case the Life Cycle Costs

In order to correct for the 3 fan types to represent only 91 % of the sold fans, total sales and stock are supposed to amount to the values calculated in task 2, while percentages of repartition between the different types of fans are, for sales as for stock numbers, 32 % for table fans, 32 % for pedestal fans and 36 % for tower fans.

The following average prices were identified in task 2:

Price	Euros
Pedestal	70,5
Table	50,0
Tower	57,4

Table 5-5: Product price of base cases

Since no maintenance is considered for this product, the life cycle cost is simply the sum of the acquisition cost and of the energy cost corrected by the discount rate.

Product life is of 10 years. Energy price is 0.158 euro/kWh. Discount rate equals to 2 %. Collection and treatment fees of the WEEE scheme are included in the product price.

	SALES	STOCK
	1000 units	1000 units
2005	25960	176016
2006	25441	191879
2007	24932	206168
2008	24433	218776
2009	23945	229582
2010	23466	238449
2011	22996	249510
2012	22537	254692
2013	22086	253189
2014	21644	237439
2015	21211	232691
2016	20787	228037
2017	20371	223476
2018	19964	219007
2019	19565	214626
2020	19173	210334
2021	18790	206127
2022	18414	202005
2023	18046	197965
2024	17685	194005
2025	17331	190125

Table 5-6: Summary table of sales and stock of comfort fans (all types in thousand units) – EU 27

Table fans

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	10	years
B	Annual sales	8,32	mln. Units/year
C	EU Stock	56,32	mln. Units
D	Product price	50	Euro/unit
E	Installation/acquisition costs (if any)	0	Euro/ unit
F	Fuel rate (gas, oil, wood)	0	Euro/GJ
G	Electricity rate	0,158	Euro/kWh
H	Water rate	0	Euro/m3
I	Aux. 1: None	0	Euro/kg
J	Aux. 2 :None	0	Euro/kg
K	Aux. 3: None	0	Euro/kg
L	Repair & maintenance costs	0	Euro/ unit
M	Discount rate (interest minus inflation)	2,0%	%
N	Present Worth Factor (PWF) (calculated automatically)	8,98	(years)
O	Overall Improvement Ratio STOCK vs. NEW, Use Phase	1,00	

Table 5-7: LCC input for table fan

	Products *Item*	LCC new product	total annual consumer expenditure in EU25
D	Product price	50 €	416 mln.€
E	Installation/ acquisition costs (if any)	0 €	0 mln.€
F	Fuel (gas, oil, wood)	0 €	0 mln.€
F	Electricity	23 €	142 mln.€
G	Water	0 €	0 mln.€
H	Aux. 1: None	0 €	0 mln.€
I	Aux. 2 :None	0 €	0 mln.€
J	Aux. 3: None	0 €	0 mln.€
K	Repair & maintenance costs	0 €	0 mln.€
	Total	73 €	558 mln.€

Table 5-8: LCC output for table fan

Pedestal fans

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	**10**	years
B	Annual sales	**8,32**	mln. Units/year
C	EU Stock	**56,32**	mln. Units
D	Product price	**70,5**	Euro/unit
E	Installation/acquisition costs (if any)	**0**	Euro/ unit
F	Fuel rate (gas, oil, wood)	**0**	Euro/GJ
G	Electricity rate	**0,158**	Euro/kWh
H	Water rate	**0**	Euro/m3
I	Aux. 1: None	**0**	Euro/kg
J	Aux. 2 :None	**0**	Euro/kg
K	Aux. 3: None	**0**	Euro/kg
L	Repair & maintenance costs	**0**	Euro/ unit
M	Discount rate (interest minus inflation)	**2,0%**	%
N	Present Worth Factor (PWF) (calculated automatically)	**8,98**	(years)
O	Overall Improvement Ratio STOCK vs. NEW, Use Phase	**1,00**	

Table 5-9: LCC input for pedestal fan

	Products *Item*	LCC new product	total annual consumer expenditure in EU25
D	Product price	71 €	587 mln.€
E	Installation/ acquisition costs (if any)	0 €	0 mln.€
F	Fuel (gas, oil, wood)	0 €	0 mln.€
F	Electricity	23 €	142 mln.€
G	Water	0 €	0 mln.€
H	Aux. 1: None	0 €	0 mln.€
I	Aux. 2 :None	0 €	0 mln.€
J	Aux. 3: None	0 €	0 mln.€
K	Repair & maintenance costs	0 €	0 mln.€
	Total	93 €	729 mln.€

Table 5-10: LCC output for pedestal fan

Tower fans

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	**10**	years
B	Annual sales	**9,36**	mln. Units/year
C	EU Stock	**63,36**	mln. Units
D	Product price	**57,4**	Euro/unit
E	Installation/acquisition costs (if any)	**0**	Euro/ unit
F	Fuel rate (gas, oil, wood)	**0**	Euro/GJ
G	Electricity rate	**0,158**	Euro/kWh
H	Water rate	**0**	Euro/m3
I	Aux. 1: None	**0**	Euro/kg
J	Aux. 2 :None	**0**	Euro/kg
K	Aux. 3: None	**0**	Euro/kg
L	Repair & maintenance costs	**0**	Euro/ unit
M	Discount rate (interest minus inflation)	**2,0%**	%
N	Present Worth Factor (PWF) (calculated automatically)	**8,98**	(years)
O	Overall Improvement Ratio STOCK vs. NEW, Use Phase	**1,00**	

Table 5-11: LCC input for tower fan

	Products *Item*	LCC new product	total annual consumer expenditure in EU25
D	Product price	57 €	537 mln.€
E	Installation/ acquisition costs (if any)	0 €	0 mln.€
F	Fuel (gas, oil, wood)	0 €	0 mln.€
F	Electricity	21 €	151 mln.€
G	Water	0 €	0 mln.€
H	Aux. 1: None	0 €	0 mln.€
I	Aux. 2 :None	0 €	0 mln.€
J	Aux. 3: None	0 €	0 mln.€
K	Repair & maintenance costs	0 €	0 mln.€
	Total	**79** €	**688** mln.€

Table 5-12: LCC output for tower fan

In average, the energy consumption represents 27 % of the life cycle cost for the end-user of comfort fans.

Tower fan electric power is lower in average than for table or pedestal but energy consumption is of the same level as for table and pedestal because of the stand-by energy.

Standby electricity represents about 4 % of the total life cycle cost for a tower fan, and about 1 % of total expenditure over the life cycle for the whole EU market fan.

5.4 EU Totals

Aggregate the Real-Life Base-Case environmental impact data (subtask 5.3) and the Life Cycle Cost data (subtask 5.4) to EU-25 level, using stock and market data from task 2, indicating the life cycle environmental impact and total LCC of the new products designed in 2005 (this relates to a period of 2005 up to 2005+product life);The annual (2005) impact of production, use and (estimated) disposal of the product group, assuming post-RoHS and post-WEEE conditions.

5.4.1 Impact and LCC of new products installed in 2005

The total weight of products installed in 2005 is about 80 kt. Materials and their end of life fate is shown in the figure below.

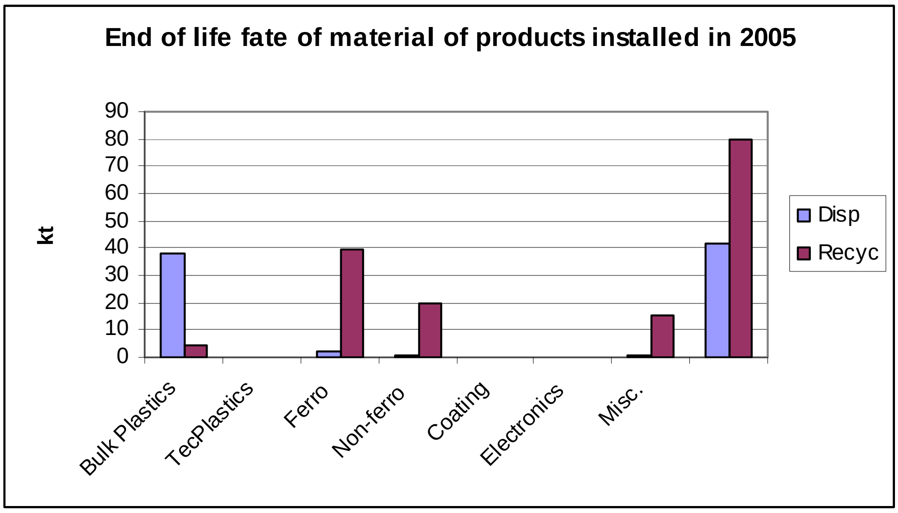


Figure 5-4: End of life fate of material of comfort fan products installed in 2005

Concerning other resources and waste,

	Material	Manuf.	Distribution	Use	EoL	TOTAL
Total Energy (GER), PJ	6.8	2.4	10.1	42.8	0.7	62.8
of which, electricity (in primary PJ)	0.4	1.4	0.0	42.8	0.0	44.6
Water (process), mln. m3	0.6	0.0	0.0	2.9	0.0	3.4
Water (cooling), mln. m3	2.9	0.6	0.0	114.0	-0.1	117.5
Waste, non-haz./ landfill, kt	315.8	8.5	5.6	52.8	7.4	390.0
Waste, hazardous/ incinerated, kt	0.2	0.0	0.1	1.0	37.9	39.3

Table 5-13: Environmental impact of comfort fan products installed in 2005, energy, water and waste

Over their lifetime, products sold in 2005 will consume 4.2 TWh between 2005 and 2015.

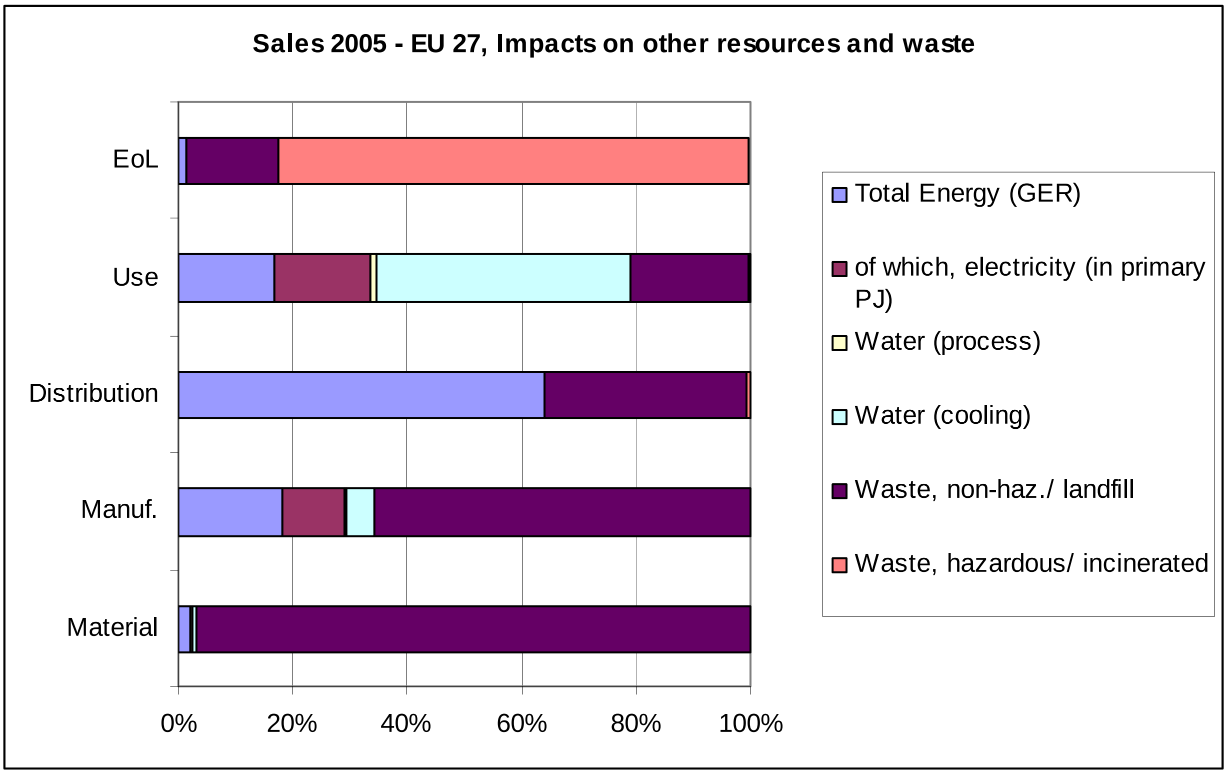


Figure 5-5: Environmental impact of comfort fan products installed in 2005, energy, water and waste

	Material	Manuf.	Distribution	Use	EoL	TOTAL
Greenhouse Gases in GWP100 (Mt CO2 eq)	0.3	0.1	0.8	1.9	0.1	3.2
Acidification, emissions, kt SO2 eq.	4.6	0.6	2.6	11.1	0.2	19.0
Volatile Organic Compounds (VOC), kt	0.0	0.0	0.1	0.0	0.0	0.1
Persistent Organic Pollutants (POP), g i-Teq	1.2	0.1	0.0	0.3	0.1	1.6
Heavy Metals, ton Ni eq.	1.1	0.2	0.3	0.7	0.8	3.2
PAHs, ton Ni eq.	0.2	0.0	0.2	0.1	0.0	0.5
Particulate Matter (PM, dust)	0.4	0.1	2.8	0.2	3.9	7.4

Table 5-14: Environmental impact of comfort fan products installed in 2005, emissions to air

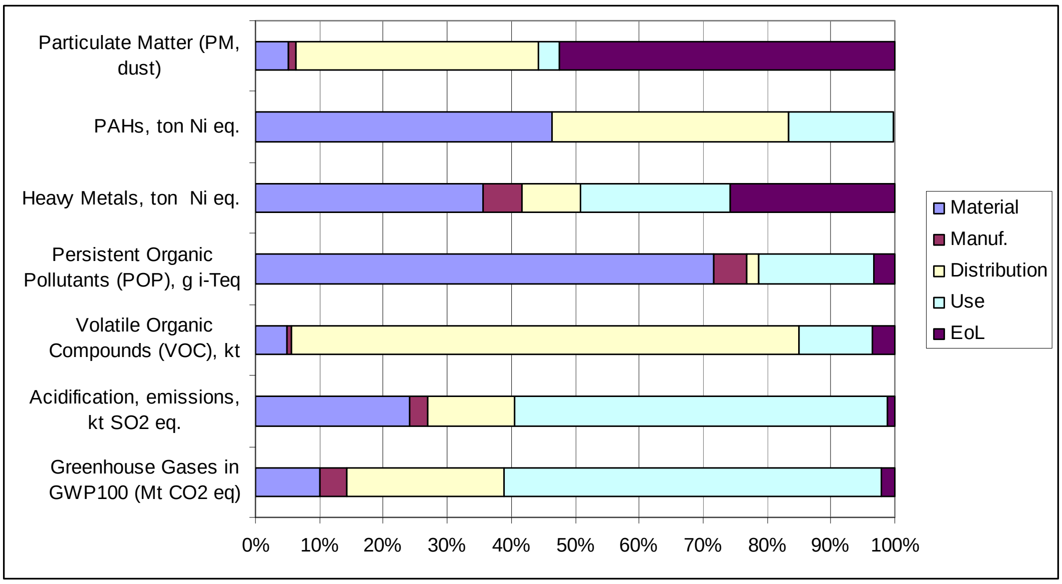


Figure 5-6: Environmental impact of comfort fan products installed in 2005, emissions to air

Emissions (Water)	Material	Manuf.	Distribution	Use	EoL	TOTAL
Heavy Metals, ton Hg/20	1.6	0.0	0.0	0.3	0.2	2.1
Eutrophication, kt PO4	0.0	0.0	0.0	0.0	0.0	0.0

Table 5-15: Environmental impact of comfort fan products installed in 2005, emissions to water

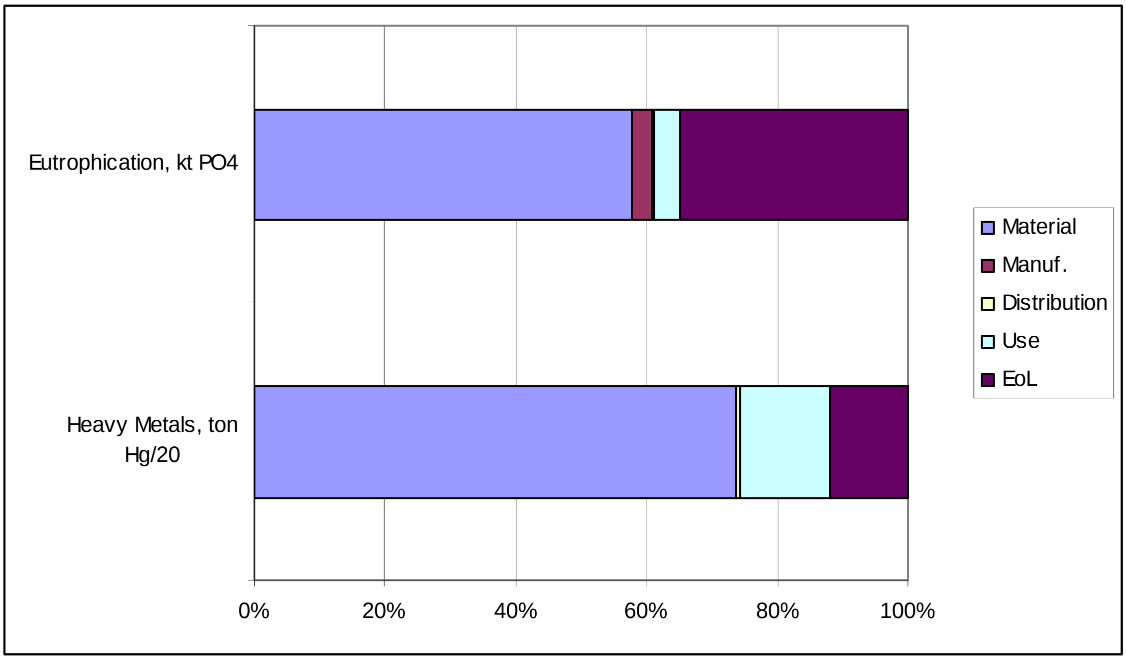


Figure 5-7: Environmental impact of comfort fan products installed in 2005, emissions to water

Total expenditure for the end-user will be:

	LCC of 2005 sales Mln euros
Product price	1540
Electricity	435
Total	1975

Table 5-16: Total expenditure of comfort fans instaled in 2005, between 2005 and 2015

5.5 EU-25 Total System Impact

Using the estimates of task 4 to estimate the total environmental impact of the product system and compare with outputs from input/output analysis (e.g. EIPRO study).

		2005	2010	2015	2020	2025
		Resources and waste				
Total Energy (GER)	**PJ**	**49.0**	**66.4**	**64.8**	**58.5**	**52.9**
of which, electricity	TWh	**2.9**	**4.0**	**3.9**	**3.5**	**3.2**
Water (process)*	mln.m3	**2.5**	**3.4**	**3.3**	**3.0**	**2.7**
Waste, non-haz./ landfill*	kton	**373.0**	**505.3**	**493.1**	**445.7**	**402.9**
Waste, hazardous/ incinerated*	kton	**39.0**	**52.8**	**51.5**	**46.6**	**42.1**
		Emissions (Air)				
Greenhouse Gases in GWP100	mt CO2eq.	**2.6**	**3.5**	**3.4**	**3.1**	**2.8**
Acidifying agents (AP)	kt SO2eq.	**15.4**	**20.9**	**20.4**	**18.5**	**16.7**
Volatile Org. Compounds (VOC)	kt	**0.1**	**0.2**	**0.2**	**0.2**	**0.1**
Persistent Org. Pollutants (POP)	g i-Teq.	**1.5**	**2.1**	**2.0**	**1.8**	**1.7**
Heavy Metals (HM)	ton Ni eq.	**2.9**	**4.0**	**3.9**	**3.5**	**3.2**
PAHs	ton Ni eq.	**0.5**	**0.7**	**0.7**	**0.6**	**0.5**
Particulate Matter (PM, dust)	kt	**7.3**	**9.9**	**9.7**	**8.7**	**7.9**
		Emissions (Water)				
Heavy Metals (HM)	ton Hg/20	**2.0**	**2.7**	**2.7**	**2.4**	**2.2**
Eutrophication (EP)	kt PO4	**0.0**	**0.1**	**0.1**	**0.0**	**0.0**
*=caution: low accuracy for production phase						

Table 5-17: Total environmental impact of the stock of comfort fans between 2005 and 2025

Total impact is about one tenth of the one of air conditioners for the stock of products in 2005 and remains stable until 2020 while the air conditioner impact increases largely by 2025 and comfort fan impact remains stable.

Indeed, the dynamics of the environmental impact of the product stock follows the trend of the stock of products which is supposed to reach its maximum by 2015 with 30 % increase and then to decrease until 2025 to reach the same order of magnitude of the 2005 stock because of the competition with air conditioners.

Task 5 summary

Three base cases have been defined for most common types of comfort fans: table, pedestal and tower fans. Bills of material of the base case exhibit similar material composition.

The analysis of environmental impact shows that the two main life phase is the use phase and the production phase. Then, the material that enters in the composition of the product are an important parameter to reduce the overall environmental impact of comfort fans.

In average, the energy consumption represents 27 % of the life cycle cost for the end-user of comfort fans. Tower fan electric power is lower in average than for table or pedestal but energy consumption is of the same level as for table and pedestal because of the stand-by energy. Standby electricity represents about 4 % of the total life cycle cost for a tower fan, and about 1 % of total expenditure over the life cycle for the whole EU market fan.

Total impact is about one tenth of the one of air conditioners for the stock of products in 2005 and remains stable until 2020 while the air conditioner impact increases largely by 2025 and comfort fan impact remains stable. Indeed, the dynamics of the environmental impact of the product stock follows the trend of the stock of products which is supposed to reach its maximum by 2015 with 30 % increase and then to decrease until 2025 to reach the same order of magnitude of the 2005 stock because of the competition with air conditioners.

6 TECHNICAL ANALYSIS BAT

6.1 State-of-the-art of the product

The market is dominated by low cost assembly of low cost parts in China. Some appearance features explain the price differences (aspect of the product).
On the EU market there is absolutely no correlation between price and energy performance (here the IEC 879 service value):

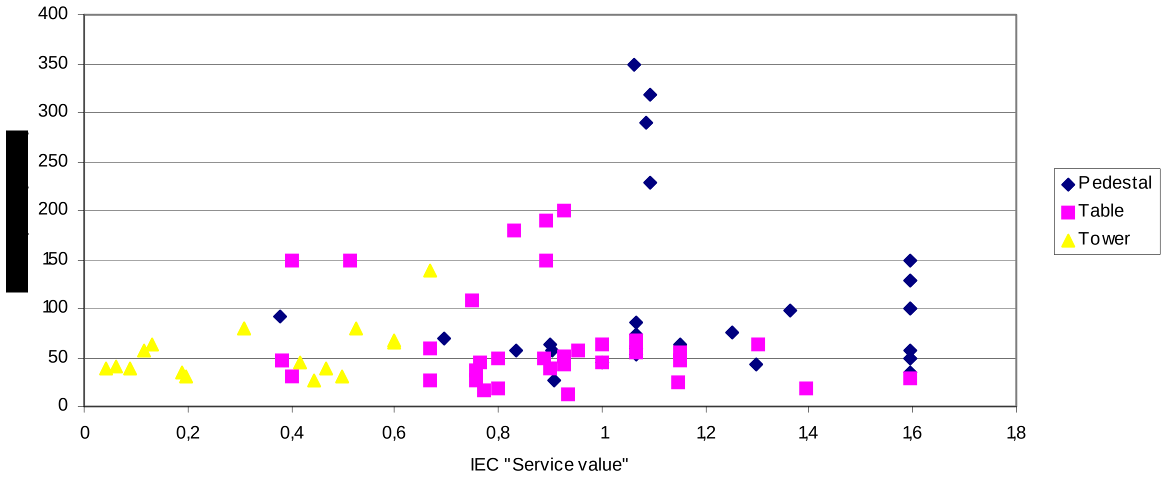


Figure 6-1: Declared service value and cost

Regarding the improvement of fan efficiencies, only ceiling fans have been studied. For example, (Schmidt, 2001) and (Parker, 1998) have presented new designs of ceiling fans based on the improvement of motor and blade efficiencies.

The Nexant study (2003) indicates the controller is not properly treated in standards and may provide improvement opportunities (not explained).

6.2 State-of-the-art for motors and possible improvements

The electrical motor can be improved. The fan power demand represents 85 % of the product electrical demand in the only case for which we found the data (the rest being the oscillation). There are products with two motors for the two motions, and products with a gear using part of the output of the main motor. The motors used tend to be the least efficient and the least costly.

Motor improvement goes by discrete steps : from 1 phase shaded pole up to collector and then up to asynchronous (Electronic Commutation being too expensive but feasible), not by continuous improvements. So we are obliged to use arbitrary values associated with the discrete changes, like 20 to 30 % then 30 to 40 %. We based our practical value on the ventilation report, since lot 11 was not available in our range of power.

6.3 State-of-the-art for blades and possible improvements

Ceiling fans blades : best performers in the USA can be found on the DOE data basis, but do not correspond to a residential market in Europe.

The blades are either axial or tangential according to fan type but generally flat (even if twisted). Blades optimised with CFD could increase efficiency from 20 to 40 %, but at a cost : manufacturing more and more complex shapes.

The directional aspect of the tower fan is certainly one way of improvement : focusing the flow.

To understand the difference one can observe the way a circular fan evacuates the flow in all directions, as opposed to tower fans. See part 4.4 for details.

6.4 State-of-the-art for control and possible improvements

The Nexant study (2003) indicates that there are two types of controllers, resistor-type speed regulator is far less efficient than the electronic controller, a fact that the test standard ignores because it provides only measurements at full speed. No figure is given.

For this study the only control option that we can introduce is the automatic management of standby power in tower fans as defined in lot 6.

6.5 State-of-the-art : is tower fan an improved table fan?

The directional aspect of the tower fan as well as the lateral encasing of box fans give one way of improvement. The future fan would not move all the air in the room, with some drawbacks (flying papers…) but direct a jet to a precise place: cool people not move air. The tower fan of today generates the same local velocity, the same flow (if we admit our measurements) at a higher investment cost (+7.50 Euros), but a lower running cost (40W instead of 50W). Furthermore, comfort cannot be compared since a focused zone of flow may be very pleasant compared to the usual air movement all around the room. Tower fan can be seen as an improvement option of table fans. The remote controller is not a compulsory part of the tower fan. We will investigate if this improvement option is cost effective.

Task 6 summary

On the EU market there is absolutely no correlation between price and energy performance.

Regarding the improvement of fan efficiencies, only ceiling fans have been studied in the past. The motors used in products sold on EU market tend to be the least efficient and the least costly. Blades optimised with CFD could increase efficiency but at a cost : manufacturing more and more complex shapes. The reduction of standby power (as defined in lot 6) seems feasible in tower fans.

The directional aspect of the tower fan is certainly one way of improvement. The directional aspect of the tower fan as well as the lateral encasing of box fans give one way of improvement. The future fan would not move all the air in the room, with some drawbacks (flying papers…) but direct a jet to a precise place: cool people not move air. Tower fan can be seen as an improvement option of table fans.

7 IMPROVEMENT POTENTIAL

Scope: Identify design options, their monetary consequences in terms of Life Cycle Cost for the consumer , their environmental costs and benefits and pinpointing the solution with the Least Life Cycle Costs (LLCC) and the Best Available Technology (BAT).
The assessment of monetary Life Cycle Costs is relevant to indicate whether design solutions might negatively or positively impact the total EU consumer's expenditure over the total product life (purchase, running costs, etc.). The distance between the LLCC and the BAT indicates —in a case a LLCC solution is set as a minimum target— the remaining space for product-differentiation (competition). The BAT indicates a medium-term target that would probably be more subject to promotion measures than restrictive action. The BNAT (subtask 6.5) indicates long-term possibilities and helps to define the exact scope and definition of possible measures.

7.1 Costs Scenarios

On the EU market there is absolutely no correlation between price and energy performance. So we cannot find an LLCC by observing the market. We have to build technical scenarios based on improved components.

We extract from the ventilating fans study some applicable techniques. The efficiency of a comfort fans is not strictly defined (but proportional to IEC service value). So changes defined for ventilation products can be applied on the efficiency and will translate proportionally on electricity consumption for the same service. The starting point, if expressed as an efficiency, would be a 4% efficiency, both for tower fans and circular table fans.

Table 7-1: Improvement potential of the different residential ventilation products, translated to comfort fans service value

Option	Description	Partial Eff. gain	Over Cost (Euros)
Motor ➚ 1st improvement	1 phase shaded pole ➚ up to collector	20 ➚ 30 %	0.5
Motor ➚ 2nd improvement	Collector ➚ up to Asynchronous	30 ➚ 40 %	0.5
Motor ➚ 3rd improvement	➚ Electronic commutation	40 ➚ 70 %	5.0
Axial or tangential ➚ optimal shape	Blade optimised with CFD	20 ➚ 40 %	1

According to lot 6 report[13], the reduction of standby from 2 W down to 0.2 W costs 0.2 Euro and is optimal. This improvement can be applied here only in the case of tower fans with a remote control, on the basis of 1120 hours of stand-by.
It lowers the 2.9 kWh (of stand-by mode) down to 0.3 kWh, an annual saving of 2.6 kWh.

7.2 Tentative LCC curve

Ranking of the individual design options by LCC (e.g. option 1, option 2, option 3);
Estimating the accumulative improvement and cost effect of implementing the ranked options simultaneously (e.g. option 1, option 1+2, option 1+2+3, etc.), also taking into account the above side-effects;

[13] page 7-4, last line

Ranking of the accumulative design options, drawing of a LCC-curve (Y-axis= LLCC, X-axis= options) and identifying the Least Life Cycle Cost (LLCC) point and the point with the Best Available Technology (BAT).

7.2.1 Table fans

By applying the individual options, we obtain the following table. The range of service values shown in chapter 4 is from 1 to 5 or 10 but we do not trust a number of declarations. The values obtained here display a lower variation range, but are based on an engineering approach.

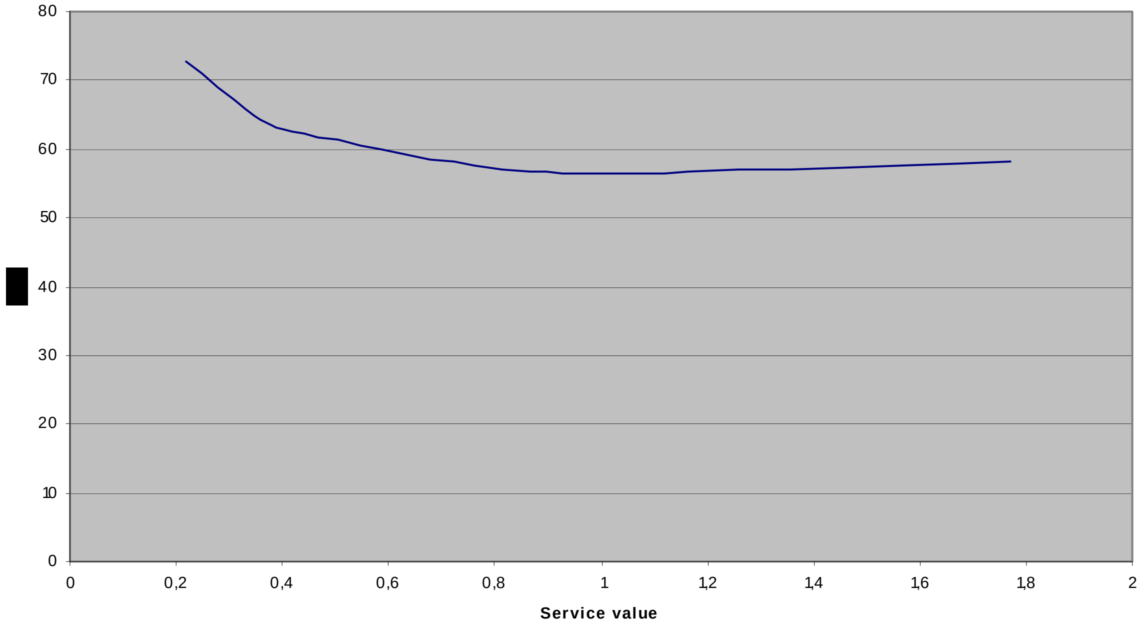
Table 7-2: LCC input and results Table fans

LCC variations	Base case	(a)CFD blades	(b) Motor1	(c) Motor2	(a+b)	(a+c)	(a)+ motor 3	Tower[14]
General characteristics								
Power W	50 (42.5[15])	28.75	33.33	25	14.5	10.87	6.21	38
Elec. kWh	16[16]	9,20	10,67	8,00	4,64	3,48	1,99	12.8
LCC input (euros)								
Price	50	50.5	50.5	51	51	51.5	55.5	53.5[17]
Installation	-	-	-	-	-	-	-	-
Maint. 4%	-	-	-	-	-	-	-	-
LCC unit (euros)								
Product price	50	50.5	50.5	51	51	51.5	55.5	53.5
Installation costs	-	-	-	-	-	-	-	-
Electricity	22,71	13,06	15,14	11,35	6,59	4,94	2,82	17,26
Rep & maint.	-	-	-	-	-	-	-	-
TOTAL	72,71	63,56	65,64	62,35	57,59	56,44	58,32	70,76
Elec / total ratio	31,2%	20,5%	23,1%	18,2%	11,4%	8,7%	4,8%	24,4%
LCC of new products installed in 2005 (euros)								
Number of products (M)	8.32	8.32	8.32	8.32	8.32	8.32	8.32	8.32
Product price	416	420,16	420,16	424,32	424,32	428,48	461,76	445,12
Installation costs	-	-	-	-	-	-	-	-
Electricity	142,4	81,9	94,9	71,2	41,3	31,0	17,7	108,2
Rep & maint.	-	-	-	-	-	-	-	-
TOTAL	558,4	502,0	515,1	495,5	465,6	459,4	479,4	553,3
Service value (m3/min)/W	0.22	0,38	0,33	0,44	0,76	1,01	1,77	0.60

In the values, we can look for minimum LCC and display it in terms of service value, the efficiency index of the international standard.

[14] without remote control
[15] 85% of power assumed to go to main movement
[16] 320 hours equivalent
[17] 4 Euros have been subtracted for the not needed remote controller

Figure 7-1: LCC against service value for a table fan (or pedestal fan, by adding the cost of the column)



The tower fan is not a cost effective option compared with the increase of efficiency of classic table fans : it has not been shown on figure 7-1.. The LCC curve shows an optimum service value for table fans around 1.00, compared with a declared value of 0.60, a measured value of 0.22 and a Taiwanese MEPS around 0.70.

7.2.2 Pedestal fans

By applying the individual options, we obtain the same results than for table fans, with an additional cost of 20.50 Euros for the “column”. The number of units sold is similar.

The LCC curve shows an optimum service value around 1.00, compared with a declared value of 0.60, a measured value of 0.22 and a Taiwanese MEPS around 0.70.

7.2.3 Tower fans with a remote control

By applying the individual options, we obtain the following table. Let us note that among tangential fans used in small air conditioners in Japan there is a factor 2 between service values of the best and worst tangential fan. The fans are used encased in that case (hence the distinct SV) but even the worst has been optimized already a lot in the case of air conditioners. We are not surprised with the potential improvement that we disclose.

Table 7-3: LCC input and results of Tower fans with remote control

LCC variations	Base case	Stand By IM	(a) Motor1	(b) Motor2	(c) Motor 3	Standby+ Motor1	Standby+ Motor2	Standby+ Motor 3
General characteristics								
Power W	40	40	17.33	14.50	10.9	17.33	14.50	10.9
Standby W	2	0.2	2	2	2	0.2	0.2	0.2
Elec. kWh	15.7[18]	13.1	7,8	6,9	5,7	5,8	4,9	3,7
LCC input (euros)								
Price	57.5	57.7	58.0	58.5	63.5	58.2	58.7	63.7
Installation	-	-	-	-	-	-	-	-
Maint. 4%	-	-	-	-	-	-	-	-
LCC unit (euros)								
Product price	57.5							
Installation costs	-	-	-	-	-	-	-	-
Electricity	21,35	18,48	11,05	9,76	8,13	8,19	6,90	5,27
Rep & maint.	-	-	-	-	-	-	-	-
TOTAL	78,75	76,18	69,05	68,26	71,63	66,39	65,60	68,97
Elec / total ratio	27,11%	24,26%	16,00%	14,30%	11,35%	12,33%	10,52%	7,64%
LCC of new products installed in 2005 (euros)								
Number of products (M)	9.36	9.36	9.36	9.36	9.36	9.36	9.36	9.36
Product price	537,3	540,1	542,9	547,6	594,4	544,8	549,4	596,2
Installation costs	-	-	-	-	-	-	-	-
Electricity	150,56	130,38	77,94	68,87	57,34	57,76	48,69	37,16
Rep & maint.	-	-	-	-	-	-	-	-
TOTAL	687,8	670,5	620,8	616,4	651,7	602,5	598,1	633,4
Service value (m3/min)/W	0.60	0.60	1,38	1,66	2,20	1,38	1,66	2,20

For tower fans, the standby improvement as planned in the IM seems the most urgent improvement, followed by use of better motors. Besides standby, we can look for minimum LCC and display it in terms of service value, the efficiency index of the international standard.

[18] 12.8 kWh (320h active mode) + 2.9 kWh (1120h stand-by mode)

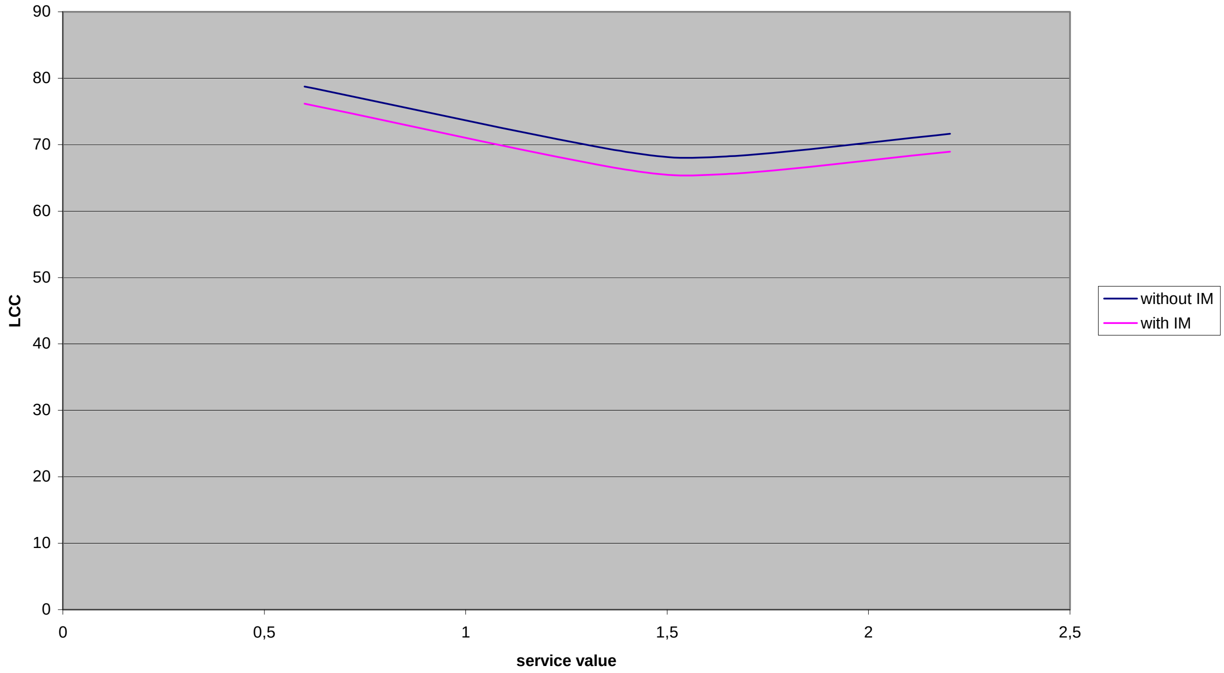


Figure 7-2: LCC against service value for a tower fan with and without the effect of the standby IM

The LCC curve shows an optimum service value around 1.50, compared with a declared value of 0.60 for the starting point, confirmed by our experiments.

7.3 Long-term targets (BNAT) and systems analysis

The difference already existing in performance and customer perception between standard circular fans and directional tower fans indicates one possible direction for BNAT : far lower flows, but directed at the right place, like in airplanes, and some trains.

Task 7 summary

On the EU market there is absolutely no correlation between price and energy performance. So we cannot find an LLCC by observing the market. We have to build technical scenarios based on improved components.

The LCC curve shows an optimum service value for table and pedestal fans around 1.00, compared with a declared value of 0.60, a measured value of 0.22 and a Taiwanese MEPS around 0.70.

For tower fans, the standby improvement seems the most urgent improvement, followed by use of better motors. The LCC curve shows an optimum service value around 1.50, compared with a declared value of 0.60 for the starting point, confirmed by our experiments.

The difference already existing in performance and customer perception between standard circular fans and directional tower fans indicates one possible direction for BNAT : far lower flows, but directed at the right place, like in airplanes, and some trains.

8 SCENARIO-, POLICY-, IMPACT- AND SENSITIVITY ANALYSIS

Scope: This task summarizes and totals the outcomes of all previous tasks. It looks at suitable policy means to achieve the potential e.g. implementing LLCC as a minimum and BAT as a promotional target, using legislative or voluntary agreements, labelling and promotion. It draws up scenarios 1990 – 2020 quantifying the improvements that
can be achieved vs. a Business-as-Usual scenario and compares the outcomes with EU environmental targets, the societal costs if the environmental impact reduction would have to be achieved in another way, etc.
It makes an estimate of the impact on consumers (purchasing power, societal costs) and industry (employment, profitability, competitiveness, investment level, etc.) as described in Appendix 2 of the Directive, explicitly describing and taking into account the typical design cycle (platform change) in a product sector. Finally, in a sensitivity analysis of the main parameters it studies the robustness of the outcome.

8.1 Introduction to scenarios

General situation of stakeholders, standardisation, foreign measures

The equipment in question is manufactured outside of the EU (we have located one hundred factories in China) . There is a certain “branding” of imported equipment by EU brands but none of them has accepted to contribute to the study, despite of numerous contacts. The brands are relatively concentrated but there is also non branded equipment. The “big brands” which appear seem not to be manufacturers themselves but want to offer a complete directory to customers.

No performance declaration mentions the relevant IEC standard. The consultant made various approaches to balance the lack of contribution of importers: generating a large data base of declared performance; purchasing equipment, checking some performance in conditions close to the IEC standard, establishing the BOM of purchased equipment. The declarations of performance of manufacturers or importers are largely in contradiction with measured values. These contradictions make more difficult the establishment of a labelling system that would inform the consumers.

It makes also very difficult the setting of a MEPS that would be needed (we will see the figures hereunder). In those conditions, the proposal is to set a provisional MEPS based on Taiwanese MEPS (the continental China MEPS is not a real performance MEPS, but more a design standard).

However, the implementation of the minimum requirements at the level of the Taiwanese MEPS will help Europe to save 0.85 TWh by 2020, corresponding to 0.37 Mt of CO_2. A second step can be taken in the context of the revision of the measure when a proper EN standard including part load is available. This will allow Europe to take an important step towards savings while simultaneously developing the knowledge of actual performance for a tougher measure.

Scope of potential actions

The scope of this study is limited to “comfort fans”. This name is suggested to represent all subtypes of products in legislation and on name plates, in a way allowing to differentiate them from ventilation fans. Some commercial names of the subtypes identified are the following ones:

- Table-desk fan,
- Wall fan,
- Floor fan,
- Pedestal fan,

- Ceiling fan,
- Tower fan,
- Box fans.

The existing limit of 125 W found in the Prodcom categories corresponds to the residential range of products, that can be used in many other places than dwellings. The options shall be applied to fans that could be declared under code Prodcom 29.71.15.30, i.e. Table, floor, wall, window, ceiling or roof fans, with a self contained electric motor of an output <= 125 W (output being understood as electrical power), which includes tower fans, box fans, either marketed for households or for any other purchaser.

Do we have suitable testing standards?

The main testing standard is an IEC standard, not yet transformed into a CENELEC standard, but completely applicable : IEC 60879 "Performance and construction of electric circulating fans and regulators". It is interesting to note that tower fans are not explicitly covered but the standard can be applied anyway. However we suggest that a CENELEC version of IEC 60879 is mandated by the Commission (with explicit inclusion of the tower fans and optional part load testing) and that a significant number of tests are ordered to one laboratory to investigate all testing issues and to be certain that the market has been largely cleaned from false declarations. In three to five years, we could obtain from CENELEC committees a development of the procedures defined in the testing standard IEC 879, for technical reasons (adaptation to EU market) and also to generate some EU know how to test those products. This would allow :
- generating an EU standard completely compatible with the existing IEC,
- having at least two labs in Europe,
- indicating applicability to "tower fans" (not explicitly covered in IEC),
- indicating that the control is part of the product, and so providing part load test options, which could lead to some improvements,
- demanding to report not only total flow but also velocities, so as to enable comparison of the tower fans which do not move the air in the whole room as opposed to other types of fans.

The noise can be measured as well. ISO 10302:1996 and EN 60704-2-7 are both available for the purpose.

Can we do independent testing in Europe, despite of lack of manufacturers? IMQ is an EU laboratory certified for testing comfort fans, and this gives us the possibility of making calls for bids, and to have at least one answer. The selected laboratory, whoever it is, should start a compliance campaign just to check manufacturers declarations on which we have emitted large doubts.

Energy and environmental study : the necessity of introducing actions

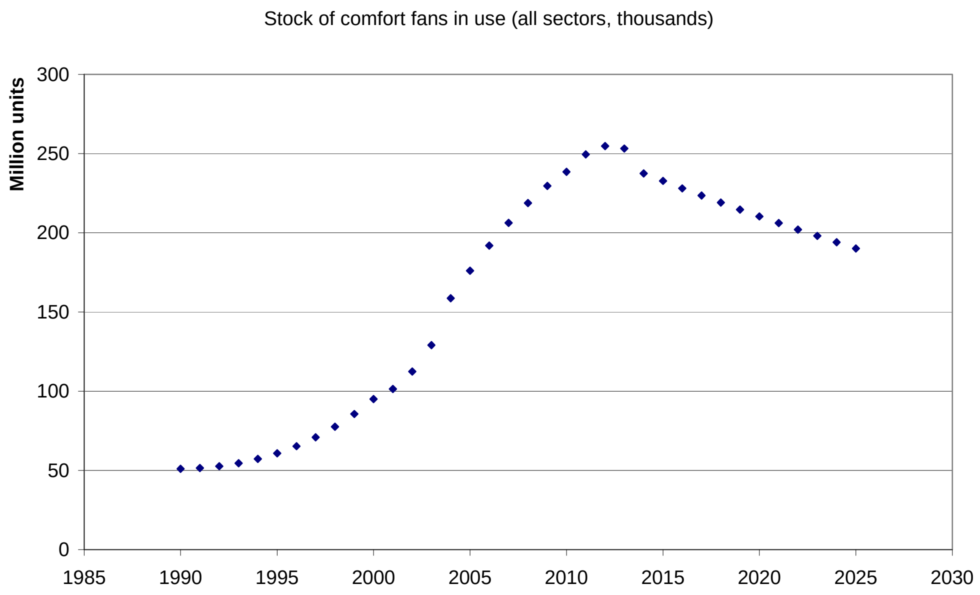
Sales of comfort fans in the EU have been increasing from 10 to 25 million units from 2000 to 2005, with a peak value for sales in 2004 at 35 million units, the year after the heat wave. It is interesting to note that the effect of the heat wave seems to show that the same phenomena occurred for comfort fans as for air conditioners: demand in 2003 was higher than the stock available and sales exploded really in 2004, when adding the fear of a new heat wave to the 2003 demand not answered. 2005 sales are then comparable to 2003 sales. Frequency of the different categories are 29 % for the table, 29 % for the pedestal fans (basically the same product) but more surprisingly 33 % for tower fans. Table 8.1 gives intermediate values.

	SALES	STOCK	MARKET
	1000 units	1000 units	M Euros
2005	25960	176016	607
2006	25441	191879	595
2007	24932	206168	583
2008	24433	218776	572
2009	23945	229582	560
2010	23466	238449	549
2011	22996	249510	538
2012	22537	254692	527
2013	22086	253189	517
2014	21644	237439	506
2015	21211	232691	496
2016	20787	228037	486
2017	20371	223476	477
2018	19964	219007	467
2019	19565	214626	458
2020	19173	210334	449
2021	18790	206127	440
2022	18414	202005	431
2023	18046	197965	422
2024	17685	194005	414
2025	17331	190125	406

Table 8-1: Summary table of sales and stock of comfort fans (all types in thousand units) – EU 27; market in Million Euros was estimated with weighted minimum retail price

All of the 250 million comfort fans in the stock in 2010 (year of the maximum expected stock –see figure 8.1) are not in residential use. Some are used in dwellings, and some are used in working places. Our experience suggests half/half. The consumption figures and other environmental indicators have been determined with that assumption.

Figure 8-1: Total EU25 stock forecast



In the catalog of manufacturers, the tower fans appear to be less efficient to generate air flow while experimental test carried out to measure efficacy for a certain number of fans showed that on the contrary they were more efficient than the table and box fan tested, which by the way had performances far below declared values concerning air flow rates. Based on the declared value, most fans are compliant with Chinese and Taiwanese standards but not all. Based on the limited experimental performance assessment led within the project, there is a significant margin for performance improvement and a lot of non compliance of producing countries with their own standards.

A pragmatic approach of minimum performance requirements

The IEC standard, which is not mentioned by manufacturers and importers, is in any case a full load test standard. The consultant based its knowledge of actual performance on the test of some equipment and on some declarations. Most fans have 3 speeds, which are practically used. Efficiency falls rapidly with air flow reduction, as low as 50 % of nominal efficiency at about 40 % air flow rate. It was thus convenient to estimate a number of equivalent full load operation and to apply it to full load performance.

Equivalent number of hours of full load operation is 320 hours and also 1120 hours of stand-by operation for units with a remote controller. In average, the energy consumption represents 27 % of the life cycle cost for the end-user of comfort fans. Tower fan electric power is lower in average than for table or pedestal but energy consumption is of the same level as for table and pedestal because of the stand-by energy. Standby electricity represents about 4 % of the total life cycle cost for a tower fan, and about 1 % of total expenditure over the life cycle for the whole EU market fan.

The study looked in a quantitative manner at all phases of the lifecycle of the products: materials use, manufacturing, transport, distribution, installation and maintenance, use, end of life. The environmental impact of the products is largely dominated by energy consumption. If the declared performance were true, we could introduce immediately the following LLCC levels as MEPS options. However there is a need for a preliminary phase of information cleaning, where the only defendable MEPS are foreign MEPS of manufacturing Asian countries.

	Our tests	Declarations	LLCC	BAT
Service Values in (m3/min)/Watt for Table fans	0.22	0.60	1.00	1.77
Service Values in (m3/min)/Watt for Pedestal fans	0.22	0.60	1.00	1.77
Service Values in (m3/min)/Watt for Tower fans	0.60	0.60	1.50	2.20

Table 8-2: Summary table of Service Values that can be achieved in (m3/min)/Watt (the larger, the better); the lack of participation of SH made impossible to determine distinct values for different sizes

How to use the existing foreign MEPS to base provisional EU MEPS

An ideal MEPS for comfort fans should be Part Load but in the present situation of MS experience it can only be Full Load; and it seems to us premature to define it exactly due to the risk of erroneous declarations. Also, in the absence of SH, it seems impossible to define exactly the influence of diameter and size. We can however base the first option on international experience, the only evidence that cannot be questioned : one major manufacturing country is already requesting that performance level.

The first step in the direction of a MEPS would be to enforce the Taiwanese and Chinese MEPS on the products sold in Europe. The proposed limit is given on table 8-3 in the wording of the IEC 60879 testing standard, and could be associated with some marking.

Table 8-3: MEPS of service value for comfort fans based on Taiwan and Mainland China minimum performance value (2002), by type and diameter

Fan type	Fan diameter [cm]	Taiwanese MEPS [(m^3/min)/W]	Chinese MEPS [(m^3/min)/W]	Proposed MEPS [(m^3/min)/W]
Tower	-	-	0.40	0.40
All fans except tower and ceiling	0-20	?/0.64	?	0.54
	20-23	?	0.54	0.54
	23-25	?	0.64	0.64
	25-30	?	0.74	0.74
	30-35	0.81	0.80	0.81
	35-40	0.87	0.90	0.90
	40-45	0.92	1.00	1.00
	45-50	0.92	1.10	1.10
	50-60	0.91	1.13	1.13
	60+	0.87	1.30	1.30
Ceiling fans	0-60	?	?	0.54
	60-90	0.87	?	0.87
	90-105	1.15	2.75	1.15
	105-120	1.15	2.79	1.15
	120-130	1.46	2.93	1.46
	130-140	1.45	2.93	1.45
	140-150	1.45	3.15	1.45
	150+	1.47	3.33	1.47

Noise levels of the Chinese standards can be readily applied in Europe.
The international standard is very clear about declarations and tolerances and can be readily applied to market control.

Can we have a normal and immediate energy labeling of those products?

The magnitude of the discrepancies discovered by the consultant leads us to reject the attribution of the prestigious EU energy label (from A to G) on the basis of the present manufacturers and importers declarations. Only when information has been cleaned, this will become possible. In the meanwhile since the IEC 879 standard says only that "service value" (which is a good Energy Efficiency Index) and the "rated air delivery" (flow rate) "shall be supplied on request" and that very few manufacturers really indicate it at the time of sale, a temporary requirement should transform this into an obligation. It will be revised when a real labeling of the product becomes possible.

We think that the market can be cleaned from false information in two years, if a compliance study is ordered simultaneously to one testing laboratory. At the same time the EN standard can be mandated and may benefit of the tests being carried out at the same time.

Standby and off mode of comfort fans

Horizontal option on standby and off mode is applicable and cost effective (in fact slightly higher performance may be cost effective as well). There is a growing segment of fans with a remote control (tower) and a standby consumption. No technical problem foreseen in applying the option.

Discussion of further possibilities of MEPS and labelling

After some time of implementation of the provisional MEPS, there will be a need for a revision. The revised EU MEPS should be Part load based. This MEPS has to be designed when the real performance of equipment is known, typically two years after the application of labeling and first MEPS. It could lead to the LLCC in a period like three years and to BAT by steps in 2015. We should say that it is difficult to outline it due to the presumption of erroneous declarations today. Even the first MEPS, although based on foreign experience (Taiwan) could be put in question if the manufacturers declarations change substantially when they start referring to the international IEC standard instead of mentioning no specific testing standard.

Noise levels being evenly distributed between 40 and 50 dBA, and due to the existence of a recognized international standard, we can request that the products are under 45 dBA at that time. However the availability of noise data is so small that no requirement on noise can be published immediately with certainty.

8.2 Scenario considered in the study : obtaining correct information on the products and applying light requirements

Definitions and scope. *A comfort fan is any product designed to give a velocity to the air inside of a room in order to improve human comfort. Among them tower fans are defined by the feature for moving the air : a cross-flow (tangential) turbine. Among the other fans, ceiling fans are defined by the system that allows an horizontal operation: a hanging system with fixation on the ceiling. The scope of the study is limited to comfort fans with a power under 125W.*

First requirement. *No product in the scope shall be put on the market if it does not bear a marking plate with "electricity use" in Watt, "service value" in (m^3/minute)/W and "rated air delivery" in m^3/minute with the indication of the testing standard IEC 879, and "noise" in dBA and the indication of the testing standard used : ISO 10302:1996 or EN 60704-2-7. This shall apply at the latest two years after publication of the requirement.*

Second requirement*. The requirements about Standby and Off mode of EuP apply completely to the products in the scope, with no delay compared with other products.*

Third requirement. *No product in the scope shall be put on the market if it does not reach the minimum service value and the maximum noise limit given by the table hereunder. For this verification the IEC 879 tolerance of 10% on air flow (and consequently on service value) will apply. This shall apply at the latest three years after publication of the requirement.*

Fan type	Fan diameter [cm]	Service value minimum acceptable [(m^3/min)/W]	Maximum acceptable Noise In dB(A)
Tower fans	-	0.40	50
All comfort fans except tower and ceiling	0-20	0.54	59
	20-23	0.54	59
	23-25	0.64	60
	25-30	0.74	61
	30-35	0.81	63
	35-40	0.90	65
	40-45	1.00	67
	45-50	1.10	68
	50-60	1.13	70
	60+	1.30	73
Ceiling fans	0-60	0.54	62
	60-90	0.87	62
	90-120	1.15	65
	120-130	1.46	67
	130-140	1.45	70
	140-150	1.45	72
	150+	1.47	75

Additional measures

A revision of the study should be started three years after publication of the requirements, to obtain a better knowledge of performance of equipment on the market, after the effect of the preceding requirements.

A CENELEC version of IEC 60879 should be mandated by the Commission (with explicit inclusion of the tower fans and optional part load testing) and a significant number of tests should be ordered to one laboratory with present IEC standard and EN version of it to investigate all testing issues and to be certain that the market has been largely cleaned from false declarations.

A new MEPS should be put in practice five years after publication of the first requirements, with noise and energy thresholds, based on the EN standard.

A labeling system should be then put in practice based on the EN standard and results of the testing campaign.

8.3 EU-25 Total System Impact for the scenario considered

If the information cleaning measures and the (Taiwanese-Chinese) MEPS are introduced rapidly they will start to act in 2010 and will have their effect in 2020 when the stock has been renewed. A revised

MEPS based on the EN standard and on the BAT, introduced after 2010 by steps until 2015, may have its full effect in 2025 when the stock is compliant. By interpolation we can compute the following gain.

		2005	2010	2015	2020	2025
BAU- Electricity consumption	TWh	**2.9**	**4.0**	**3.9**	**3.5**	**3.2**
Scenario with first MEPS- Electricity consumption	TWh	**2.9**	**3,96**	**3,30**	**2,65**	**1,99**
Potential evolution with revised MEPS leading to BAT - Electricity consumption	TWh	**2.9**	**3,96**	**2,98**	**1,99**	**1,01**
Savings with first MEPS- Electricity consumption	TWh	**0,00**	**0,04**	**0,60**	**0,85**	**1,21**
Savings with BAT - Electricity consumption	TWh	**0,00**	**0,04**	**0,92**	**1,51**	**2,19**
Savings with first MEPS- CO2 emissions	Mt CO2	**0,00**	**0,02**	**0,26**	**0,37**	**0,52**
Savings with BAT CO2 emissions	Mt CO2	**0,00**	**0,02**	**0,40**	**0,65**	**0,94**

Table 8-3: Electricity impact (total electricity over LC) of the stock of comfort fans between 2005 and 2025 in the scenarii proposed

8.4 Sensitivity Analysis

Many factors can influence our results. One can consider varying raw materials and electricity prices and other relevant macro economic variables. However the LLCC found are robust to these variables.

The basic data on the market are uncertain since no market study was pre existing. The study mentioned low uncertainties in PRODCOM reporting, and this is a good point.

The projections made are relatively uncertain. The central question is: how will be the competition between comfort fans and air conditioning in more insulated buildings in a warming climate? This information will decide on the future market trends: either the stable evolution as before or a quick market change in the direction of air conditioners. Other uncertainties are related to the demand of the end user for more comfort in air quality.

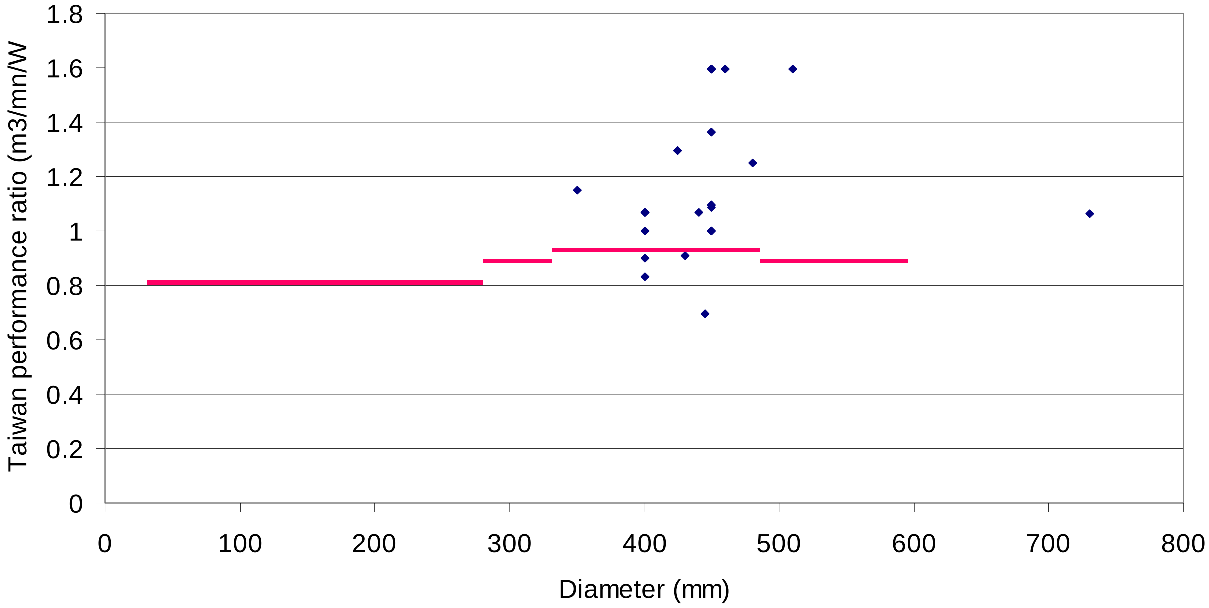
For comfort fans the duration of use is largely uncertain.

However none of those uncertainties may influence the first phase of policies.

8.5 Impact on Stakeholders

If the information in present manufacturers declarations has been obtained in accordance with international standards, only 20% of the production can be impacted by the three requirements and will be submitted to less than 20% of improvement demand, while there are products with “service value” improved by a factor 2. The impact on manufacturers will be light or null, since there is no proprietary technology and the impacted manufacturers will simply order the parts they assemble to some other OEM. For instance the market transformation for pedestal fans will be to rise equipment under the line up to the line in the following graph:

Figure 8-2: Comparison of EU pedestal fans performances and of the Taiwanese requirements



However, if the information in present manufacturers declarations has not been obtained in accordance with international standards (but is made proportional to the IEC values, as a computational assumption), all the production outside of tower fans will be impacted by the three requirements and will be submitted to an improvement demand by a factor 2, leading all the market to the best existing level today. Some manufacturers will risk a lot due to their past erroneous declarations, but a different timing could be then negotiated. However if the Chinese standard is already implemented by Chinese manufacturers in all their productions (domestic and exports) there will be no additional cost for them.

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