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COMMISSION STAFF WORKING DOCUMENT

Accompanying document to the

Proposal for a Commission Regulation implementing Directive 2005/32/EC with regard to ecodesign requirements for fans within a 125 W to 500 kW power range

FULL IMPACT ASSESSMENT

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FULL IMPACT ASSESSMENT

Lead DG: TREN

Associated DG: ENTR

Other involved services: SG, LS, ENV, COMP, ECFIN, INFSO, MARKT, SANCO, TRADE, RTD, JRC

1. PROCEDURAL ISSUES AND CONSULTATION

1.1 Organisation and timing

The implementing measure for fans is one of the priorities of the Action Plan on Energy Efficiency[1], and is part of the 2008 Catalogue of actions to be adopted by the Commission for the year 2008.[2]

The proposed implementing measure is based on the Directive 2005/32/EC of the European Parliament and of the Council establishing a framework for the Commission, assisted by a Regulatory Committee to set ecodesign requirements for energy-using products[3]. An energy-using product (EuP), or a group of EuPs, shall be covered by ecodesign implementing measures, or by self-regulation (cf. criteria in Article 17), if the EuP represents significant sales volumes, while having a significant environmental impact and significant improvement potential (Article 15). The structure and content of an ecodesign implementing measure shall follow the provisions of the Ecodesign Directive (Annex VII).

Article 16 provides the legal basis for the Commission to adopt implementing measures on this product category.

Article 19 of the Directive 2005/32/EC, amended by Directive 2008/28/EC[4] foresees a regulatory procedure with scrutiny for the adoption of implementing measures. Subject to

[1] COM(2006)545 final.

[2] COM(2008)11 final.

[3] Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC, OJ L 191, 22.7.2005, p. 29.

[4] Directive 2008/28/EC of the European Parliament and of the Council of 11 March 2008 amending Directive 2005/32/EC establishing a framework for the setting of ecodesign requirements for energy-using products, as well as Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC, as regards the implementing powers conferred on the Commission, OJ L 81, 20.3.2008, p. 48

qualified majority support in the Regulatory Committee and after scrutiny of the European Parliament, the adoption of the measure by the Commission is planned by the end of 2009.

The Commission carried out a preparatory study on fans[5] in preparation of the implementing measure. On 27 May 2008 a meeting of the Ecodesign Consultation Forum established under Article 18 of the Ecodesign Directive was held (details are provided below). The Commission was assisted in the impact assessment from February 2009 to June 2009 to analyse the likely impacts of the planned measure.

If both the Article 19 Committee and the European Parliament give a favourable opinion on the draft implementing measure and impact assessment, the adoption of the measure by the Commission is planned at the end of 2009.

1.2 Impact Assessment Board

The Impact Assessment Board (Opinion 27.07.2009) requested strengthening the justification for the scope of the proposed regulation, further analysis of the impact of setting minimum requirements for motors on the fan market structure, a more refined analysis of impacts on employment needs and an assessment of administrative burden to be aligned with the requirement of IA guidelines. The IAB comments are fully taken into account in this report.

1.3 Transparency of the consultation process

Expertise on fans was gathered in particular through a study providing a technical, environmental and economic analysis of fans (from here on referred to as "preparatory study"), carried out by external consultants[6] on behalf of the Commission's Directorate General for Energy and Transport (DG TREN).

The preparatory study followed the structure of the "MEEuP" ecodesign methodology[7] developed for the Commission's Directorate General for Enterprise and Industry (DG ENTR). The MEEuP methodology is endorsed by stakeholders and used in all ecodesign preparatory studies.

The preparatory study on fans (Lot 11 – section: Industrial Fans) was developed in an open process, taking into account input from relevant stakeholders including manufacturers and their associations, environmental NGOs, consumer organizations, and EU Member State experts. Information on the preparatory study was made publicly available through a dedicated website[8] where interim results and further relevant materials were published regularly for timely stakeholder consultation and input. The study website was promoted on the ecodesign-specific websites of DG TREN and DG ENTR. Open consultation meetings for

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5 Radgen, Dr.P., Oberschmidt, J. (Frauenhofer Institute, Germany), Cory, W.T.W. (ind. consultant, UK), "EuP Lot 11: Fans for ventilation in non-residential buildings / Final Report", April 2008. This report is part of the Lot 11 studies which also comprises electric motors, water pumps and CH circulators, of which reports can be downloaded from the website http://www.ecomotors.org .

6 Radgen, Dr.P., Oberschmidt, J. (Frauenhofer Institute, Germany), Cory, W.T.W. (ind. consultant, UK), "EuP Lot 11: Fans for ventilation in non-residential buildings / Final Report", April 2008; documentation available on the ecodesign website of the Commission's Directorate General Energy and Transport http://ec.europa.eu/energy/efficiency/ecodesign/studies_en.htm

7 "Methodology for the Ecodesign of Energy Using Products", Methodology Report, final of 28 November 2005, VHK, available on DG TREN and DG ENTR ecodesign websites: http://ec.europa.eu/energy/efficiency/ecodesign/studies_en.htm

8 Available on http:\\www.ecomotors.org

directly affected stakeholders were organised at the Commission's premises in Brussels on 29.06.2006, 5.12.2006, 2.5.2007 and 24.10.2007 for discussing and validating the preliminary results of the studies.

Further to Article 18 of the 2005/32/EC Directive, formal consultation of stakeholders is carried out through the Ecodesign Consultation Forum consisting of a balanced participation of Member States' representatives and all interested parties concerned with the product group in question.

On 27 May 2008 the Meeting of the Ecodesign Consultation Forum took place. Building on the results of the preparatory study, the Commission Services presented a Working Document (CSWD) presenting ecodesign requirements related to Fans[9]. About one month before the meeting, these working documents were sent to the members of the Consultation Forum, and to the secretariats of the ENVI (Environment, Public Health and Food Safety) and ITRE (Industry, Research and Energy) Committees of the European Parliament for information. The working documents were published on DG TREN's ecodesign website, and they were included in the Commission's CIRCA system alongside the stakeholder comments received in writing before and after the meetings. Minutes of the Meeting of the Ecodesign Consultation Forum are annexed (Annex A).

1.4 Preliminary results of stakeholder consultation

Stakeholder consultations were made on the basis of the results from the preparatory study and the Commission Staff Working Document.

The **Member States** largely agree with the suggested levels and the staged implementation of requirements. Many stakeholders considered the timing of measures in 2020 too far away. Some considered 2010 as the first implementation date too early. Some Member States disagreed with the scope of the measure, especially the inclusion of "OEM fans" (fans incorporated in assembled products). Other Member States welcomed the inclusion of OEM product fans, since this ensures that all fans, regardless of route into the EU, would need to comply with the same set of requirements.

Other points that were discussed concerned measurement methods and the definitions that apply (e.g. whether fans for cooling and heating are included).

Industry associations largely support the general approach to set mandatory minimum requirements. Furthermore, some industry supports the rating methodology in general, but a plea was held to align the methodology for expressing fan efficiency with forthcoming efficiency grading as described in the ISO 12759 standard.

Stakeholders (both Member States and manufacturers) also questioned the feasibility of and the need for phasing out cross-flow fans. Manufacturers also agreed with Member States that the suggested implementation date for the 1st stage (2010) is too early and the date for the 3rd stage (2020) too far away.

Environmental NGOs and **consumer's associations** are generally in support of the measures for fans, but contest the suggested timeframe and the level of measures. Some argued that

[9] Available on DG TREN's ecodesign website: http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm#consultation_forum

there is no justification for limiting the minimum efficiency requirement to a constant value for fans above 10 kW.

After the Consultation Forum meeting further comments were received as regards the inclusion of OEM fans incorporated in assembled products. EU manufacturers are more in favour of inclusion of all fans and consider this essential for creating a level playing field. Some manufacturers of fans and assembled products would prefer an approach on (assembled) product level only. Manufacturers also expressed concerns about proving compliance of fully integrated fans that can not be tested using standard tests. Most industry (and some Member States) was concerned about the inclusion of box and roof fans, since the fan inside would already be covered by the measure. To cover all fans and adhere to well established procedures to determine fan performance and efficiency, it would be essential to allow expressing fan efficiency in both static and/or total pressure.

2. PROBLEM DEFINITION

Fans can be found in a variety of applications, such as in industrial, commercial and residential buildings for supply of fresh air, removal of stale air and/or air-handling in general (e.g. supply of heated air, cooled air and/or de-/moisturising of ventilation air) in order to achieve certain indoor air quality conditions. The same type of fans can also be found in a number of appliances or equipment that do not directly affect indoor air quality but are related to cooling and heating of certain installation components. As the technical scope of a fan can not be limited to a given application or an end-use sector, this impact assessment is based on fans full-filling the technical criteria for axial, centrifugal, cross-flow, box and roof fans in the power range of 125 W – 500 kW, as defined in the preparatory study and in accordance with views of stakeholders. Other considerations to use this power range for the scope were the following:

- to avoid an overlap with Lot 10, as fans of less than 125 W are usually applied in the domestic sector and already covered by Lot 10;

- the upper limit of 500 kW allows the existing range of fans to be covered;

- trade statistics also use the division in fans below and above 125 W. In order to describe the market a deviation of the 125 W value would complicate matters unnecessarily.

Fans can thus consist, in terms of products placed on the market, of fan impellers alone and impellers with a motor. Fans can be equipped with a casing, transmission and/or variable speed drive.

A certain number of fans in the power range of 750W – 375 kW are run by motors covered by the draft motor Regulation. The overlap with the motor measure in this power range is taken into account as explained further on.

The underlying problem can be summarized as follows: although energy efficient products and technical solutions exist on the market leading to lower power consumption of fans and fan products without negatively affecting their functionality or cost, the market penetration of such products remains limited.

As requested by Article 15 of the Ecodesign Directive, the preparatory study identified the environmental aspects in relation to fans, they:

(1) have a significant environmental impact within the Community;

(2) present significant potential for improvement without entailing excessive costs;

(3) are not addressed properly by market forces (market failure);

(4) are not sufficiently addressed by other relevant Community legislation (see part on existing legislation).

2.1 Market size

The following fan (sub-)types are distinguished.

Table 2.1a: Types of fans and fan products covered

Fan type	sub-type
Axial	static pressure difference ≤ 300 Pa
	static pressure difference > 300 Pa
Centrifugal	forward curved blades in scroll shaped housing
	plug/plenum fan (no scroll housing)
	backward curved or aerofoil blades in scroll housing
Cross-flow	
Box fans	(irrespective of fan type inside)
Roof fans	Axial fan inside
Roof fans	Centrifugal fan inside

In the text below the term 'fans' refer to all these types of products, if not otherwise indicated.

The impact assessment identified sales of some 13 million fans in the EU27 in 2005, increasing to almost 17 million fan units in 2020. The sales value of the 2005 fan sales is around 5,5 billion EUR (industry turnover). Annex D – Sales describes the size of the fan market as defined in this impact assessment.

Most of these fans are axial types (40% of sales in 2005), roof fans (27% of fan sales) or box fans (18% of fan sales). An overview of annual sales by fan type is given below. The last line shows the relative increase of fan sales against the 2005 situation.

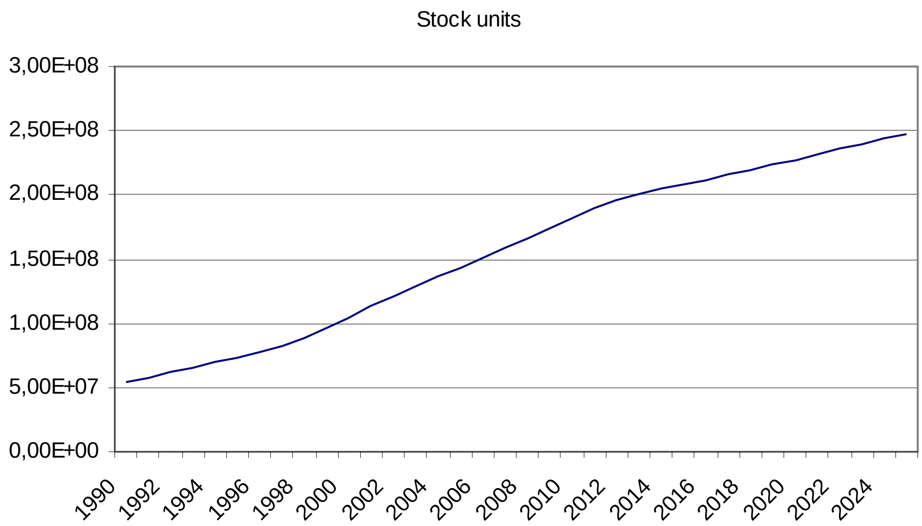
Table 2.1b: Fan sales by type

Fan type	**sales [mio units]**						
	1995	2000	2005	2010	2015	2020	2025
Axial<300Pa	0,90	2,25	2,40	2,62	3,00	3,39	3,78
Axial>300Pa	0,93	2,51	2,70	2,86	3,01	3,17	3,33
Centr.FC	0,46	0,66	1,12	1,04	1,20	1,36	1,52
Centr.BC-free	0,14	0,21	0,33	0,31	0,35	0,39	0,43

Centr.BC	0,14	0,23	0,37	0,34	0,39	0,44	0,49
Cross-flow	0,13	0,23	0,19	0,26	0,30	0,34	0,37
Box	1,53	2,58	2,30	2,91	3,13	3,35	3,57
Roof_all	1,99	3,87	3,40	4,10	4,33	4,55	4,78
TOTAL	6,23	12,54	12,81	14,44	15,72	16,99	18,27
			100%	113%	123%	133%	143%

The total installed base or stock of fans is highly dependent on the expected growth rate of fan sales, especially for high volume products such as roof fans, box fans and high pressure (> 300 Pa) axial fans and the product life (used was 15 years). This Impact Assessment identified a stock of 143 million units in 2005, rising to 227 million in 2020.

Figure 2.1: Fan stock 1990 - 2025

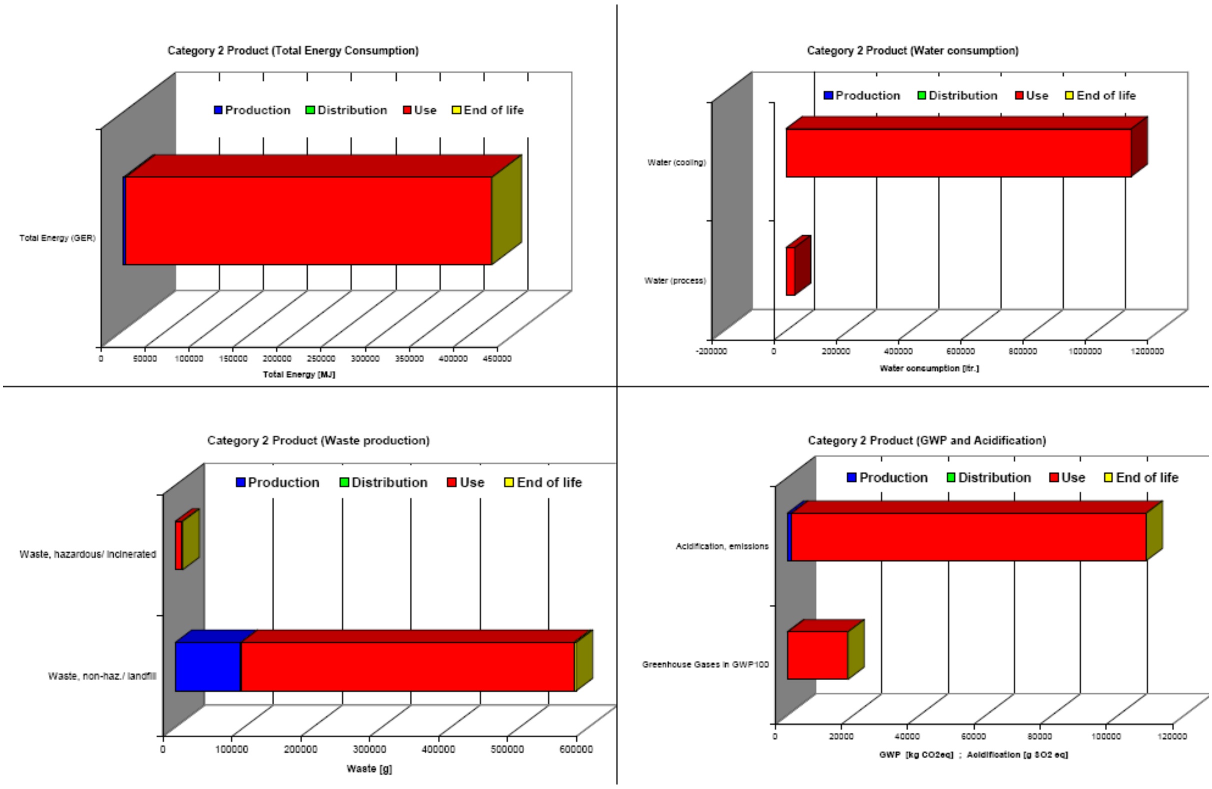


2.2 Environmental impact

The preparatory study defined, with the consent of stakeholders consulted during the study, eight base cases (for each fan type) describing the average fan of this type and its lifecycle (from material inputs, typical usage to end-of-life).

The figure below gives a graphical representation of the impacts of an Axial fan (< 300Pa) during its lifecycle for several environmental impact categories. Other fan base cases (categories) show a similar picture. Only box and roof fans show somewhat higher production related impacts due to higher product weight (extra material use for sheet metal box and/or weather resistant cowl or fan enclosure).

Figure 2.2: Life cycle impacts of a typical axial fan (> 300 Pa).



The results of the MEEuP-based life cycle analysis of all fan base cases show that the main environmental impacts in the life cycle of fans are related to energy (electricity) consumption during use.

Further significant impacts occur during the production phase and are related to emissions of hazardous substances and waste.

The end-of-life phase does not add significantly to the overall impacts. Although fans are currently not covered by WEEE or RoHS, all existing fan designs appear to be compliant with these Directives. The preparatory study also assumes, together with the stakeholders, that due to their high value all of the metallic components are recycled. The non-metallic components are considered as not recycled.

The single most significant environmental parameter (in the light of possible ecodesign measures) is therefore energy consumption during use.

When assessed at EU level the energy consumption of fans is 390 TWh/a in 2005, which represents some 179 Mt CO2 eq. or 4,4% of the EU total in 2005 (estimated at 4025 Mt CO2).

2.3 Improvement potential

In the preparatory study efficiencies of fan types, including the motor and the transmission were calculated on the basis of static pressure [10]. In every fan category there is a significant

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10 The efficiency of fans sold without an electric motor is based upon the efficiency of the impeller, complemented by default efficiencies for the transmission, electric motor and variable speed drives if

savings potential in power consumption. The lower and upper thresholds of efficiency are typically 0.6 to 0.7 lower and 1.2 to 1.3 higher than average efficiency. This suggests that considerable room for improvement exists. The actual efficiency of a fan also depends on the power requirement (high power fans are on average more efficient than low power fans).

Table 2.3: Minimum, average and maximum efficiency at base case power (includes motor and transmission)

	power [kW]	lowest eff.	average eff.	highest eff.
Axial<300Pa	0,8	20%	31%	40%
Axial>300Pa	1,32	25%	37%	47%
Centr.FC	0,44	20%	32%	42%
Centr. free/plug	3,76	45%	56%	70%
Centr.BC	3,82	45%	54%	67%
Cross-flow	0,42	5%	7%	10%
Box	0,37	15%	23%	45%
Roof_axial inside	0.9	15%	25%	35%
Roof_centr.inside	1,2	35%	44%	60%

From the table above one can determine that certain fan types appear more efficient than other fan categories. This however does not mean that one fan type is the 'most efficient' because the efficiency level does not reflect the ratio of air flow versus (static) pressure. The most efficient fan types (centrifugal backward curved) often have a high pressure and lower flow rate ratio. If the application however demands a relatively low pressure and higher flow rate other types of fans may be better suited for that application. In short, fans of different types are not always interchangeable. Improving energy efficiency by exchanging a fan for one of a different category is limited to specific applications. In many cases it is not possible or not desirable.

So substitution (e.g. exchanging an "axial" fan type for a "centrifugal backward curved" fan) is not feasible in most cases, since fans of different types have different characteristics and performance curves. Even where there is a small overlap in performance (where the required duty point can be reached by more than one fan type) there will undoubtedly be a preference of the client for a certain fan type with specific characteristics due to part load conditions, sound, or other aspects such as dimensions that determine fan selection. So fan substitution is not impossible but in general substitution should be very carefully considered, taking all system aspects into account. Often there is little advantage in selecting a different fan type if the initial decision for a fan type was taken carefully.

Benchmark

The upper range in efficiency ('highest efficiency') indicated in the table above corresponds to the best available technology identified on the market (benchmark) for fans at base case power. Since fan efficiency is dependent on input power, fans of higher power levels may show higher efficiencies and fans with lower input power show may show lower efficiencies.

applicable. The efficiency of fans sold with a motor is based upon electric power input efficiency (losses of the motor and transmission already included).

Note the fact that the data is from the year 2005 and that more efficient fans may have been developed since then does not automatically mean that the average fan efficiency is higher because the market failures, as described in section 2.4 remain.

2.3.1 *Improving fan efficiency at optimal operating point*

Reducing energy consumption within the same fan type is first of all a well thought-over selection process. If the application (based on operating point or duty point) allows for a larger fan of the same type running at lower speeds this often lowers energy consumption, so specifying the correct/optimised fan is an important first aspect in reducing fan energy consumption.

Other options to reduce energy consumption of the fan at its optimum operating point concerns improving design aspects such as impeller efficiency (improved aerodynamics etc.), applying guide vanes (improved aerodynamics), motor efficiency (from AC motors to high performance DC motors) and transmission efficiency (from V-belts to flat belts). Many fan manufacturers aim to improve one or more of these aspects to improve fan energy efficiency.

2.3.2 *Improving fan efficiency at part load conditions*

A fan uses aerodynamic principles to work and changes in the operating point of a fan influences the power consumption as well. Therefore part load control mechanisms not only influence the duty point but also the power consumption of the fan at these part load conditions and the efficiency: Each part load control has different effects. Figure B.5 in Annex B below shows the power input of a fan by fan volume for several part load control mechanisms (discharge dampers, inlet vanes, variable speed motor, controlled/variable pitch blades, cycling and the theoretical minimum). Some part load options add further resistance to the system requiring somewhat larger fans (notably discharge dampers). Other options increase the electric power consumption (e.g. variable speed drives) but these losses are easily recovered through lower power consumption at part load conditions.

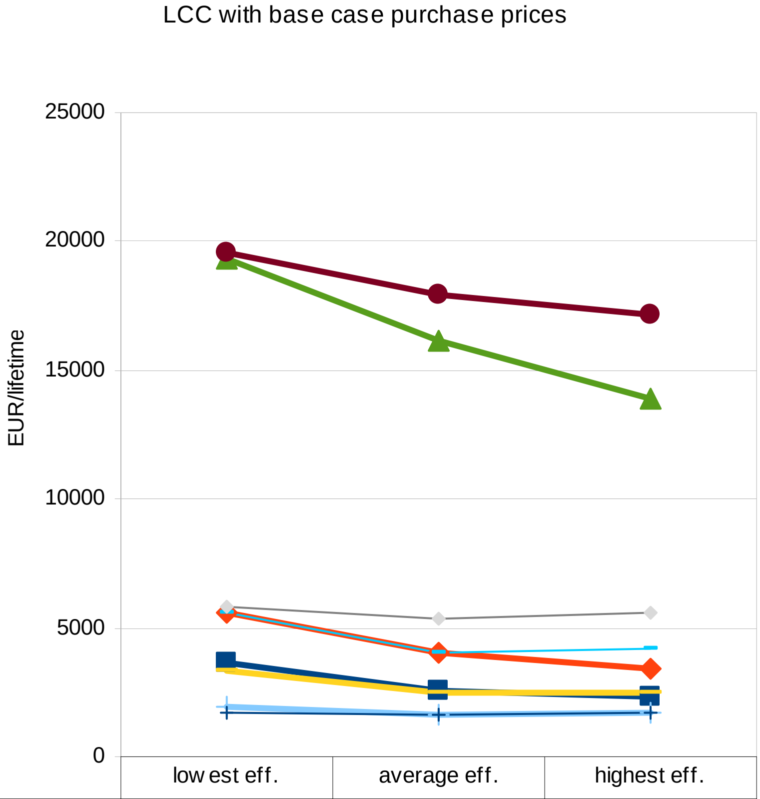
2.3.3 *Costs of improving fan efficiency*

In Annex C, the details of life cycle cost calculations for the average (base case) fan types are given. These costs are based upon base case power consumption, running hours, minimum, average and maximum energy efficiency, minimum, average and maximum fan purchase price, electricity rates and product life as described in the preparatory study.

The method assumes that the electricity consumption (average power * running hours) multiplied by the average efficiency of the base cases represent the work performed by the fan. By improving the fan efficiency the same work can be performed by a fan at lower power consumption. A calculated correlation between fan efficiency and purchase price allows the calculation of the life cycle costs of fans of higher efficiency.

The figure below shows the results for the LCC calculation using base case inputs. The columns labelled “highest” represent the best available technology (BAT).

Figure 2.3.3: LCC calculation at base case prices for fans of lowest/average/highest efficiencies.



	low est eff.	average eff.	highest eff.
Axial<300Pa	3618	2538	2354
Axial>300Pa	5596	4045	3448
Centr.FC	3300	2473	2499
Centr.BC-free	19332	16120	13927
Centr.BC	19585	17955	17192
Cross-flow	1920	1622	1694
Box	1714	1628	1734
Roof_axial	5617	4010	4168
Roof_centr.	5825	5346	5603

The analysis shows that for many (base case) fans the least life cycle costs occur around the average efficiency (centrifugal forward-curved, cross flow, box and roof fans). For axial fans and centrifugal backward curve the life cycle costs (LCC) keep reducing even when efficiency increases beyond average (towards highest efficiency or Best Available Technology level).

So there is a clear rationale for removing from the market models of less than average efficiency - and with higher LCC – as the least life cycle cost point (LLCC) is achieved at average efficiency levels for these types of fans. The fans with less than average efficiency cost more to run and cause unnecessary impacts so regulating those fans is exactly in line with article 15.5 of the Ecodesign Directive. Increasing efficiency levels for such fans would not result in raising life cycle costs as models with 'average efficiency' would not be phased out, but the ones with less than average efficiency would. The fans with average efficiency remain unaffected and will continue to be sold and their life cycle costs will remain at minimum. Only the least efficient models of fans are removed for which the LCC are higher than the minimum.

Annex C also shows the results of a sensitivity analysis for higher (list) product prices and reduced running hours. The overall conclusion is that moving the lower efficiency end of the market towards average efficiency (or beyond average efficiency for certain fan types) reduces total expenditure.

2.4 Market failure

The previous section shows that room for improvement of the efficiency of fans exists and is economical. However, the preparatory study mentions that end-users may select fans of poor efficiency whereas they could have selected fans of higher efficiencies. Several market 'failures' exist in the process of selecting the right and most efficient fan for each application.

Negative externality

Not all environmental costs are included in electricity prices. End-user choice is usually made on the basis of the purchase price, as the lower electricity price is not reflecting environmental costs for the society.

Split incentives

The engineer or designer specifying the fan for a given application (often an anonymous HVAC advisor or the supplier) is not responsible for paying the electricity bills and often not interested in the efficiency of the fan. In case of rented buildings it is difficult to propose changes to the building installation since the investment and operating expenses are borne by different parties. The same applies to appliances integrating fans; OEM manufacturers are not faced by demand of high efficiency fans.

Even if the same organisation is responsible for fan specification and operation, the specifying person often operates under a different budget than the persons responsible for the operating expenses. Maintenance can also be allotted to another budget; total-cost-of-ownership is not taken into account (split budget).

Asymmetric information

A main consumer related barrier for energy efficiency is the fact that end-users are not able to consider the full life-cycle cost of the fan. The purchase price is well visible and is typically higher for energy efficient fans. On the other hand, information on running costs/cost savings is not explicit and can be obtained only with difficulties. Initiatives exist that aim at soling this problem, such as the Danish *Spareventilator* label or the US Energy Star label. However, there is no indication that these initiatives would lead the market towards the highest efficiency fans, although the sales of lowest efficient fans would decrease to some degree.

The situation persists despite of the fact that a high efficiency fans would be a cost-efficient solution in basically all industrial applications. In addition, besides purchasing price, many users consider other factors than energy efficiency to be at least of the same importance, such as availability, service, and known brand name. As a result, manufacturers have no incentive to reduce the energy consumption of fans, even though this could be done at reasonable additional cost to the manufacturer and would bring significant savings to the consumer and reduced CO_2 emissions.

The fan market is very much an OEM market (stakeholders estimate 70-80% of fan sales are OEM), where manufacturers source fans to be used in Air Handling Units (AHU) and/or other HVAC applications. The larger clients may buy OEM fans on specification or are fan manufacturer themselves. For the end-user this means that, in general, many fans in a series-built OEM product is not as good a match in specific operating conditions as a fan that is specifically selected to meet these conditions. The split-incentive problem is also relevant (first costs appear more important than TCO).

Many fans are used in HVAC applications where energy costs for heating and cooling are often perceived as being much higher than the energy costs of 'just the fans'. However, given the often very long running hours and oversized motors the energy use by fans can be significant and even be higher than the costs for e.g. cooling. The exact energy use of fans is rarely known by building operators.

If installed and operating correctly the fan in ventilation systems does not raise much attention. Even if the fan fails it takes a while for people to notice. The product is often hidden away, in ducted systems, plenums or invisible on rooftops. The energy consumption by fans often goes unnoticed.

The energy efficiency of a fan (if considered) is just one of the many aspects the fan-specifier or buyer has to consider: Duty point, noise, brand name, reliability, feature-set, operating conditions, delivery time, etc. are often just as important as energy efficiency, if not more important. The variety in fan performances, with almost limitless fan availability in working principles, impeller sizes and designs, motor speed/rpm, motor types, transmission drives, air flow controls and part load controls makes fan selection not an easy task.

Thus fan selection has become very much a matter for specialists (familiar with Fan Laws and characteristic curves) since uninformed selection may lead to poor ventilation performance, excessive noise, reduced lifetime, irregular/unstable operation and possible overloading of the drive motor resulting in destruction of the fan. Despite of the knowledge of the specialist, its impact in the fan choice remains weak due to the preference above market failures.

2.5 Existing legislation and initiatives

2.5.1 Legislative measures

There is currently no EU level legislation on energy efficiency of fans covered by the scope of this impact assessment. The Motor Regulation may have an impact and this is described in more detail in section 5 and 6.

Several Member States are trying to influence fan efficiency indirectly by specifying a minimum performance for building ventilation systems through their national Building Codes as is the case in Sweden and the UK (Germany is considering such legislation). The basis for such legislation is a calculation of overall system performance and this includes ducts, bends, filters and many more aspects that go beyond fan efficiency alone. The unit used for specifying is often SFP (Specific Fan Power in W/m^3hr). Also the (forthcoming) prEN 13779, which is related to the EPBD, specifies SFP values for various ventilation systems. It should be noted that such measures, although very functional from a building perspective, do not necessarily increase fan efficiency. Reduced system resistance is a main effect of such legislation.

2.5.2 *Third country legislative measures*

China is the only third country with minimum efficiency requirements for fans (GB19761, latest version from 2005 and currently under revision). The scope covers centrifugal and axial fans for general use and centrifugal fans for air-conditioning applications. Fans with specific construction characteristics such as cross flow fans and roof fans are excluded from the scope. The requirements are based upon expressing efficiency by total pressure (according ISO 5801) and relates to shaft power for centrifugal and axial fans for general use and electric motor input power for centrifugal fans for air-conditioning applications. The efficiency values depend on the pressure coefficient, specific speed, hub-tip ratio and fan wheel diameter and also include a rating scheme (three grades depending on fan characteristics). The minimum efficiency values (grade 3) for centrifugal fans range from minimum 55% (high pressure coefficient, small wheel diameter) to maximum 81% (low pressure coefficient, large wheel diameter) and for axial fans from 60% to 73% depending on hub-tip ration and fan wheel diameter. These values relate to shaft input power and total pressure. For centrifugal fans in air-conditioning applications the minimum efficiency values range from 38% to maximum 55% and are related to motor input power.

Although the requirements forbid the sales of less efficient fans in China it does not forbid the Chinese production and export of these fans to other markets. For exported fans the standard defines less demanding efficiency values.

2.5.3 *Voluntary measures*

Denmark has started a voluntary labelling scheme for fans called „Spareventilator“[11]. In Denmark a fan can be called a „Spareventilator“, if it complies with a demand for high energy-efficiency as defined by the Danish power companies. Only those fans that have been approved by the power companies may be labelled.

Additionally, a number of countries have developed national guides to energy efficiency fans and fan systems such as Germany, UK, Netherlands or France[12]. No information is available which would confirm the success of these initiatives.

The Energy star program by the US Environmental Protection Agency (EPA) sets requirements on fans for residential ventilation (smaller power range). The energy star program defines eligibility criteria for residential fans to use the energy star logo. Two different product categories are covered by the energy star program: ceiling fans and the ventilation fans for bathrooms and kitchens.

The European industry has not requested voluntary measures but supports minimum requirements binding for all manufacturers and importers alike.

2.6 Relevance of product group for Eco-design Implementing measures.

As requested by Article 15 of the Ecodesign Directive, the preparatory study identified that fans fulfil the criteria for being eligible for setting ecodesign requirements because they:

(1) have a significant environmental impact within the Community;

[11] Source: http://www.spareventilator.dk

[12] Preparatory study mentions www.vdi.de/tag, www.cibse.org, www.isso.nl and www.aicvf.com.

(2) present significant potential for improvement without entailing excessive costs;

(3) are not addressed properly by market forces;

(4) are not sufficiently addressed by other relevant Community legislation .

The fan sector is economically significant. Fan unit sales in the EU27 amount to approximately 13 million units in 2005 (7.1 million driven fans and 5.7 million fan products). The combined turnover of the fan industry and trade is almost € 8 bln/a. The EU exports to third countries account for €700 million and the imports from third countries account for €336 million. Depending on the fan category, extra EU exports are 30% to 40% of the total (including intra EU) exports, indicating that the main market is EU based.[13]

Electric fans are an important type of electric load in the EU, consuming about 410 TWh/a (2005). In terms of (indirect) CO_2 emissions, fans are responsible for around 4,4% of the total CO_2 emissions in the EU27[14].

Energy saving is economical and thus abatement costs of GHG and other emissions from power generation are negative.

There are no current initiatives or measures in the EU that regulate fan energy efficiency effectively. The proposed motor Regulation will have an impact on savings from fans of 0.75 kW – 375 kW. This impact is described in Section 5.

The problem can be summarized as follows: although energy efficient products and technical solutions leading to lower power consumption of fans without negatively affecting their functionality or cost exist on the market, the market penetration of such fans remains limited.

The preparatory study has concluded that fans comply with the criteria in Art. 15, sub.1 and are therefore a subject for ecodesign measures.

3. OBJECTIVES

3.1 Objectives

As laid out in Section 2, the preparatory study has confirmed that a large cost effective potential for reducing the electricity consumption of fans exists but the potential is not tapped. The objective is to consider alternative policy options, and sub-options, if relevant, in order to correct the market failure, and which:

- reduce energy consumption and related CO2 and pollutants emissions due to use of fans following Community environmental priorities, such as those set out in Decision 1600/2002/EC or in the Commissions European Climate Change Programme (ECCP) and;

- promote energy efficiency hence contribute to security of supply in the framework of the Community objective of saving 20% of the EU4s energy consumption by 2020;

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13 Preparatory study, quoting Eurostat.

14 See section 5.2 Greenhouse gas emissions

While aiming at these objectives, the Ecodesign Directive, Article 15 (5), requires that Ecodesign implementing measures also meet the following criteria:

a) there shall be no significant negative impacts on the functionality of the product, from the perspective of the user;

b) health, safety and the environment shall not be adversely affected;

c) there shall be no significant negative impact on consumers in particular as regards affordability and life cycle cost of the product;

d) there shall be no significant negative impacts on industry's competitiveness;

e) in principle, the setting of an ecodesign requirement shall not have the consequence of imposing proprietary technology on manufacturers;

f) no excessive administrative burden shall be imposed on manufacturers.

3.2 Consistency with other EU policies

Increased market take up of energy efficient fans, through the introduction of minimum energy efficiency requirements, will contribute to reach the 20% energy savings potential identified by 2020 in the Energy Efficiency Action Plan (COM(2006)545).

Promotion of market take up of efficient fans complies with the Lisbon and renewed Sustainable Development Strategy[15] as it will encourage investment in R&D and provide for a level playing field for al.

Improving efficiency of fans belongs to one of the key objectives defined in the Community Lisbon Programme for 2008-2010 (COM(2007)804), the promotion of an "industrial policy geared towards more sustainable consumption and production" as further developed in the Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy (COM(2008)397)[16].

Last but not least, the European Economic Recovery Plan published 26.11.2008[17] mentions energy efficiency as one of the priorities and in particular promotes the rapid take-up of "green products": *The Commission will urgently draw up measures for other products which offer very high potential for energy savings such as televisions, domestic lighting, refrigerators and freezers, washing machines, boilers and air-conditioners*."

4. POLICY OPTIONS

In order to address the issues and meet the targets identified in Section 3 it is important that the increasing energy consumption of fans is curbed. The following policy options to improve energy efficiency of fans have been assessed in order to address the identified market failures as cost-efficiently as possible.

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15 OJ L 242, 10.9.2002, and Council document 10917/06 of 26.6.2006
16 Published 16.7.2008.
17 COM (2008)800

4.1 Option 1: No EU action

The current (2005) energy consumption of fans is estimated at 390TWh/a, which is estimated to rise to 630 TWh/a in 2020, an increase of 60% (BAU scenario). This is largely due to the steep increase in fan sales and stagnating average energy efficiency.

Consequently, this option is discarded.

4.2 Option 2: Self regulation / voluntary agreements

The industry argues that voluntary agreements may be difficult because of the growing share of imports. As a consequence, the industry associations fear for free riders. In particular, EU fan manufacturers selling mainly within the EU worry for level playing field. Therefore the fan manufacturing industry did not propose voluntary agreements.

Consequently, this option is discarded.

4.3 Option 3: Labelling only

Energy labelling under the European energy labelling directive 92/75/EEC is discarded for the following reasons:

Fans in the scope of this impact assessment are not household appliances, and are therefore not covered by the labelling requirements set under the current Energy Labelling Framework Directive 92/75/EEC[18].

Although, labelling of fans under the revised 92/75/EEC would in principle be possible, although with a considerable delay, the nature of markets with a majority of fans bought by OEM industry and installers would not be suitable for such a label. Additionally, the results of labelling and other information action taken at national levels do not support this approach; it would not help to alleviate the market failures identified. Providing energy efficiency information alone does not give a guarantee that the market will shift towards more efficient fan products. Already today fan efficiency can be calculated by using the fan specifications. Also, some manufacturers already indicate the efficiency in product documentation. Due to the fact that fans are mostly purchased and installed by professional installers and not final consumers, this measure would have only a limited impact.

Additionally, after the implementation of the minimum efficiency requirements, it would be difficult to distinguish seven energy efficiency classes above the proposed efficiency levels.

An endorsement label or "label of excellence", such as the Danish *Spareventilator* label or the US Energy Star label, declaring that a specific product is complying with certain energy performance levels helps OEM market actors and fan specifiers to identify more efficient fans, but does not necessarily move the market towards high efficiency fans if less efficient fans are continued to be sold and the identified market failures continue to persist.

Consequently, the option is discarded.

[18] OJ L 297 of 13.10.1992, p. 16.

4.4 Option 4: Ecodesign requirements

This option aims at improving the environmental impact of fans, i.e., setting maximum levels for their power consumption. This sub-section contains details of the rationale for the elements of the corresponding regulation, as listed in Annex VII of the Ecodesign Framework Directive.

The preparatory study and stakeholder comments lead to following four sub-options[19]:

A. Efficiency levels based on the CSWD explain and backed by the preparatory study;

B. Efficiency values based on proposals by fan manufacturing industry;

C. Efficiency values based on proposals by Environmental NGOs;

D. Efficiency values based on a compromise of the three above sub-options.

All sub-options introduce requirements identically as to introductory dates by 2012 and 2015, following comments by stakeholders in the Consultation Forum Meeting. While the sub-options and their differences are explained in detail in Annexes D and E, the main elements are listed below.

The first sub-option follows the approach taken in the CSWD backed by the preparatory study. The sub-option assumes efficiency values for 2012 and 2015 based upon the original CSWD levels backed by the preparatory study.

The second sub-option is based on the proposals by industry as expressed through the ISO 12759 Technical Committee TC117. One modification has been made to the original proposal: instead of three implementation dates this sub-option considers two implementation dates (2012 and 2015), as the proposed first levels are very low, that is, the requirements of the 2nd and 3rd stage from the industry proposal are considered. Overall, the sub-option presents lower requirements than the first sub-option. However, for Centrifugal Forward Curved, Centrifugal Backward curved with housing and Cross flow fans slightly more ambitious levels are proposed than in the first sub-option.

The third sub-option was proposed by the environmental NGOs (represented by ECOS) during the impact assessment. One modification has been made to the original document: instead of three implementation dates, two implementation dates (2012 and 2015) that are considered achievable are considered. The efficiency levels are close to those from the industry but are raised a few percentage points. The actual increase of levels when compared to sub-option 2 however varies per fan type, e.g. for Centrifugal Forward Curved fans and Cross Flow Fans efficiency levels are much higher than in sub-option 1 (twice the average efficiency for Cross Flow Fans.

The fourth sub-option was developed during the impact assessment with the objective of imposing the lowest possible burden on the industry from the start (only a minority of fans will have to be redesigned on the short-term) allowing some 'savings' to be started on 2012. Accordingly, the first stage requirements are a combination of efficiency requirements corresponding to the lowest levels proposed under the sub-options A-C, or alternatively of the

19 Annex E.

values suggested by the industry (that is, if the industry values are higher than in sub-options A and C).

The second stage aims for highest possible savings on the long-run, giving sufficient time for the industry to redesign and adapt the production accordingly. This option also takes into account the uncertainty under which the impact assessment has been drafted as to information on SMEs; the option offers maximum protection to potential manufacturers being forced to redesign their fan products, while seeking for the maximum benefit for the society. Accordingly, the second stage requirements are a compromise of the ambitious minimum requirements expressed in sub-options A-C.

The proposed fourth sub-option is considered feasible given the relatively small differences in the level of ambition between the three sub-options. It also respects the least life cycle cost levels for the customer, the redesign cycle of fans and the proposals from the industry in terms of timing.

For illustration, the comparison below presents the differences in ambition of all four sub-options when compared to the first sub-option. Detailed explanation on the colours of and the numbers in the cells are provided in Annex E.

Table 4.4: comparison of sub-options per fan category

	sub-option 1			sub-option 2			sub-option 3			sub-option 4	
Axial	ref	ref		-2	-5		-1	-2		0	0
Centr.FC	ref	ref		2	0		4	3		2	3
Centr.BC-free	ref	ref		-3	-5		1	-1		0	0
Centr.BC	ref	ref		3	-1		4	1		3	1
Cross-flow	ref	ref		1	1		5	7		1	1
Box	ref	ref		0	0		0	0		0	0
Roof_axial	ref	ref		0	0		0	0		0	0
Roof_centr.	ref	ref		0	0		0	0		0	0

4.4.1 Product scope

The scope of the proposed requirements is fans with an electric power input of at least 125 W up to and including 500 kW, independent of the sector or appliance in which they are used.

4.4.2 Implementation of ecodesign requirements

The preparatory study has shown that, depending on the functionality provided, existing cost effective technical solutions allow for fan electricity consumption levels lower than the ones currently calculated. According to Directive 2005/32/EC, the target levels for measures should be set at least life cycle cost (LLCC), which presumes that at some point the price of the product increases so much with extra design options to save energy that the life cycle costs (purchase price plus running costs) will start to rise again. The preparatory study has shown that the considered levels are cost-effective for the end user and can be achieved with current or expected state-of-the-art technology. However, the cost of the measure for the industry must be taken in due consideration.

Power levels

The CSWD presented to the Consultation Forum was based on 8 fan categories. On the basis of the stakeholder request, the impact assessment analysed and clarified the possibility of reducing the fan categories. As a main guiding technical principle, if possible, it was decided to base the categories on international/European standards in order to avoid harming the fan market through a 'regionalised approach' limited to the EU alone. Accordingly, the proposed requirements on fans are based on the draft ISO 12759 Standard (status May 2009), which defines a scheme for describing efficiency levels of fans through a grading scheme. The scheme is designed in such a way that the efficiency level (grade) of a fan can be expressed by a single number: The FMEG value (FMEG is Fan Motor Efficiency Grade). This efficiency level and the applicable mathematical formula (defined in the draft ISO 12759) for the fan type is used to calculate the efficiency of the fan throughout the power range of 0,125 kW to 500 kW.

The mathematical formulas to calculate efficiencies of fans as applied in this Impact Assessment are based on the forthcoming ISO 12759 Standard as currently developed by TC 117 and are as follows:

Fan type / fan product	**Power range**	
	0.125 kW <= Pe < 10 kW	10 kW <= Pe < 500 kW
Axial, centrifugal forward curved, roof fan with axial fan inside	2.74*ln(Pe) - 6.33 + N	0.78*ln(Pe) -1.88 + N
Centrifugal backward curved open wheel, centrifugal backward curved with housing, mixed flow, roof fan (with centrifugal fan inside) and box fan	4.56*ln(Pe) -10.5 + N	1.1*ln(Pe) - 2.6 + N
Cross flow fans	1.14 * ln(Pe) - 2.6 + N	
Comment:	N=FMEG value	

The impact assessment considered the following minimum efficiency levels (as FMEG value), by fan type and year of implementation (all referring to static efficiency):

Fan type	**Sub-option A (CSWD)**		**Sub-option B (Industry)**		**Sub-option C (EnvNGO)**		**Sub-option D (Compromise)**	
	2012	2015	2012	2015	2012	2015	2012	2015
Axial	36	40	34	35	35	38	36	40
Centr.FC	35	39	37	39	39	42	37	42
Centr.BC-free	58	62	55	57	59	61	58	62
Centr.BC	55	60	58	59	59	61	58	61
Cross-flow	11	13	12	14	16	20	12*	14*
Box	35	39	35	39	35	39	35	39

Roof_axial	27	31	27	31	27	31	27	31
Roof_centr.	48	52	48	52	48	52	48	52

* comparable with 18 respectively 21 if referring to total efficiency

Comments on the implementation of the Ecodesign requirements

The minimum efficiency requirements are based on the function performed by a fan. The proposed minimum energy performance requirements and the timing for their introduction have been set taking into consideration:

– The least life-cycle cost of the product in accordance with Annex II of Directive 2005/32/EC.

– The expected market and technology developments. The requirements will be applicable two years after the measure has entered into force (if entry into force is 2010, the first implementation date is 2012) and will correspond to the available fan technology for decreased energy use.

– Time is needed for manufacturers to redesign and manufacture new more efficient fans. As the low-efficient fans will be replaced by existing more efficient fans or redesigned to comply and the necessary production capacity must be realised, it is necessary to give time for manufacturer to make the necessary investments. Since the necessary technology has already been on the market for many years, and as many fan manufacturers already produce high efficient fans, the timeframe of two vs. four years is considered to be enough.

– It should also be considered that discussions with the affected industry started in 2006, so the coming of the measure has been know for several years.

Ecodesign parameters for which no Ecodesign requirements are necessary

In accordance with Directive 2005/32/EC and the methodology used in the preparatory studies, all environmental impacts of fans have been considered. It has been concluded that the energy consumption in the use phase is the cause, by far, of the main environmental impacts of these devices.

Other than energy-use, an environmental aspect of fans which has to be considered is their recyclability. Fans contain mainly various types of metals, which have a positive scrap value. It is to the professional installer’s advantage (in most cases, the replacement, repair and disposal or recycling of fans is managed by the installer) to send old fans to scrap and avoid a disposal cost. The preparatory study assumes, together with the stakeholders, that due to their high value all of the metallic components are recycled. The non-metallic components are considered as not recycled. Although fans are not covered by WEEE or RoHS, existing fan designs appear to be compliant with these Directives.

At this moment the possibilities to enhance the recyclability of fans through better design are very limited. The value of the materials used and the competition in the fan market makes manufacturers optimise material use and recyclability.

4.4.3 Measurement standard and method for estimation of the energy efficiency

Performance testing of fans is done using ISO 5801. The ecodesign requirements will specify (per fan category) which test set-up (fully ducted, ducted inlet, ducted outlet, free inlet/outlet) and which pressure (static or total) should be used to calculate the efficiency. Part load test procedure is not prescribed but part load conditions are in any way achieved when the fan is tested at multiple flow rates (standard procedure). If a variable speed drive is integrated (or if blade pitch is adjustable) multiple test runs at different speeds / blade angles are usually performed as well.

4.4.4 Information to be provided by manufacturers

In order to facilitate compliance checks manufacturers are requested to provide information in the technical documentation referred to in Annexes IV and V of Directive 2005/32/EC in so far as they relate to the requirements laid down in this implementing measure.

4.4.5 Date for evaluation and possible revision

The main issues for a possible revision of the Regulation are:

– appropriateness of the product scope;

– appropriateness of the levels for the ecodesign requirements for the efficiency of allowed fans.

With a view to the level of requirements proposed, a review can be presented to the Consultation Forum five years after entry into force of the regulation.

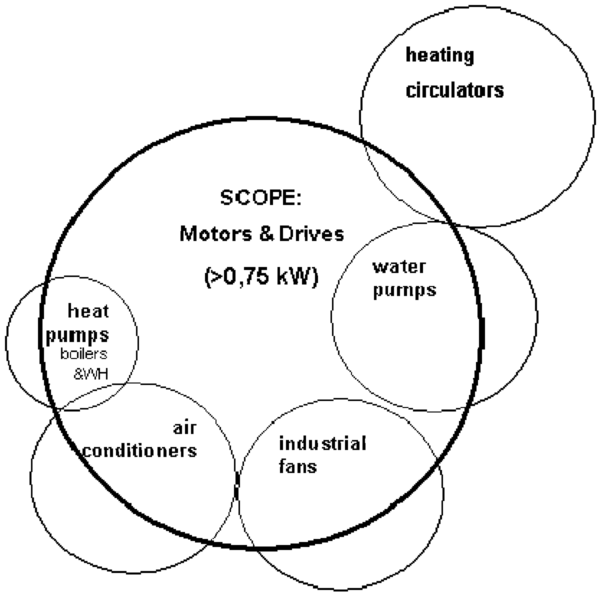
4.4.6 Overlap with other EuP product groups

A number of implementing measures on products related to fans is currently under development under the Ecodesign Directive. An implementing measure on motors was voted by the Regulatory Committee on 11 March 2009 and a Consultation Forum meeting on comfort fans below 125 W took place on 22 June 2009. Coordination between these product groups has been assured as far as relevant (e.g. as to efficiency calculation methods or measurement standards, efficiency levels considered and potential impact on markets thereof).

In terms of possible overlap in energy saving, electric motors are the only product group that is relevant for fans. Electric motors in the power range of 750 W – 375 kW, including the use of variable speed drives in connection to motors of certain efficiency level are regulated in a specific Ecodesign Regulation on motors (Commission adoption foreseen in July 2009).

The diagram below illustrates the possible overlap (based on energy consumption and in saving potential) between relevant industrial appliances (source: Impact Assessment Electric Motors).

Diagram 4.4.6a: potential overlap between products.



The impact assessment on motors estimated a general overlap of some 30% between motors and appliances driven by these motors. As the electric motor measure is expected to increase the energy efficiency of motors this will impact the calculated fan efficiency, which includes the efficiency of the fan motor (either as a default value for fan impellers or directly). This impact is taken into account as follows.

There is no overlap between measures for fans and motors in power ranges 125 W - 750 W and 375 kW – 500 kW. As to the overlap in the power range 750 W – 375 kW on the driven fan, the preparatory study on fans assumes a default motor efficiency corresponding to IE1 as defined in the IEC 60032-30 Standard. This default efficiency level will remain the same for all fans products placed on the market without a motor (the current method assumes the default values do not change).

The actual motor efficiency is expected to increase from IE1 to IE2 by 16 June 2011 due to the motor Regulation. Furthermore, the efficiency of one third of the motors in the power range of 7.5 kW – 375 will further increase to IE3 on 2015. The same efficiency increase will take place again on 2017 for one third of motors in the power range of 0.75 kW – 7.5 kW.

The table below shows the default motor efficiency as is assumed for the assessment of the overlap in energy savings by the combined motor and fan measures.

Table 4.4.6b: Default motor efficiency vs. actual efficiency.

Categories of motors applied in fans	**Motor default efficiency in efficiency calculation method based on preparatory study**	**Actual motor efficiency after 16. June 2011 for 0.75 kW-375kW**	**Actual motor efficiency after 1. January 2015 for power range 7.5 kW-375kW**		**Actual motor efficiency after 1. January 2017 for power range 0.75 kW-375kW**	
			For 1/3 of motors	For 2/3 of motors	For 1/3 of motors	For 2/3 of motors
125W≤750W	IE1	IE1	IE1	IE1	IE1	IE1
≥0.75≤7.5kW	IE1	**IE2**	IE2	IE2	**IE3**	IE2
≥7.5≤375kW	IE1	**IE2**	**IE3**	IE2	IE3	IE2
≥375-500kW	IE1	IE1	IE1	IE1	IE1	IE1

The impact of the increased efficiency of the motor could be taken into account in two alternative ways:

– in integrating the impact of the increased motor efficiency into the scenario calculations, or;

– in deducting the impact of the increased motor efficiency from the end results of the scenario calculations.

Based on input from stakeholders and experts, the latter method has been chosen with arguments as follows:

– the draft Motor Regulation is not yet existing law;

– the motor efficiency default value used is identical to the preparatory study. Using an identical approach in the impact assessment makes comparison between the two underlying documents transparent;

– the default motor efficiency value does not change identically across the power range nor within power ranges, which would lead to complex scenario calculations;

– Consultation with the fan manufacturing industry during the impact assessment has proven that the European fan industry is poorly organised[20] and is not capable in providing

[20] There is no single European fan manufacturing association that is representing the European fan industry as a whole. Eurovent, national associations, national and/or European standardisation bodies are possible groupings of fan manufacturers representing their interests and have been consulted during this Impact Assessment. Gathering of market data is also made more difficult since there are wide discrepancies in activities of fan manufacturers (some fan manufacturers only produce fans of a certain

information at the level of detail required for such an analysis. The European fan industry is not capable of providing the fan market split up in segments 0.125-0.75 kW, 0.75-7.5 kW, 7.5-375 kW and 375-500 kW, for all eight fan types, for three possible fan-motor configurations (integrated motor, direct drive, transmission drive), the motor type (induction motor or not) nor the three possible efficiencies of induction motors applied (IE1/2/3).

– Even if such information was available (which is not the case) adding such detail to the analysis makes the analysis many times more complex (4 market segments * 8 fan types * 3 fan-motor configurations * 2 motor types (induction or not) * 3 motor efficiencies * 4 sub-options gives 2304 possible combinations);

– Motor efficiency is only part of the total fan efficiency. Example: Assuming an average fan with an impeller efficiency of 40% and a motor efficiency of 80% the total driven fan efficiency is 32%. Increasing motor efficiency by 5% increases total fan efficiency by only 2%. Therefore, an increase in fan efficiency through increased motor efficiency should not be overstated and can be assessed using less detailed approach ;

– All **fan base cases** identified in the preparatory studies are below 7,5 kW (sales weighted average is approximately 1,1 kW). Therefore it can be assumed that the effects of the Motor Regulation for the year 2015 are relatively small since the average fan motor is smaller than 7,5kW. Furthermore the effects of measures will not be totally visible until 2030 when the total fan stock will be replaced (2015 + 15 year fan product life). The motor measure of 2017 will change base case fan efficiency more effectively (applies to base case fan power) but the resulting effects will be modest when reviewed for base year 2020 (only 1/5 of stock replaced).

The overlap in terms of savings in the power range 0.75-375 kW is derived as follows:

– based on the preparatory study, 80% of the total power consumption is generated by fans above 750 W;

– the number of fans above 375 kW are, according stakeholders estimates, very small, the 80% consumption is assumed to cover the power range 750W – 500 kW;

– Based on the above table, the default motor efficiency increases by an average of 5%[21] from IE2 to IE3 and an additional 3% from IE2 to IE3[22]. The table below shows the fan efficiencies per type of fan;

– Total savings from increased fan efficiency is calculated according the target values as set in the sub-options. Part of these savings is due to increased motor efficiency, part of it is from increased impeller efficiency or other efficiency aspects.

– The savings from increased efficiency of the default motor is considered to be proportionate of the presence of affected motors in the total fan population and the effect it

type in a certain power range, whereas other are producing very broad ranges of fans and a third company may just apply OEM fans into their final products) and fan sales are difficult to track since a large part of the fan market is OEM market.

21 However, the efficiency of the total fan product will be less, subject to the efficiency of the other parts of the product.

22 Default motor 1,5 kW with 4 poles.

has on the total fan efficiency. The proportionate savings can therefore be deducted from the aggregate outcome of the scenario calculations, as detailed in Chapter 6.

The implementing measure on electric motors is not expected to lead to a significant change for the total sales volume of fans nor for the market share of different fan types because these market shares depend foremost on the applications these fans fulfil. Fan type substitution might happen, but only for a limited amount of applications and probably only in those cases where both variants are already available as products on the market.

As regards the Motor Regulation, a majority of fans utilise electric motors that are outside the scope of the motor regulation so these will only be affected by the proposed Fan Regulation. Fans that do apply motors that fall under the Motor Regulation are affected by both Regulations (Fan and Motor Regulation) and here the Motor Regulation will only be instrumental in achieving part of the savings required by the Fan Regulation. This effect is quantified in section 6.2.

The effect of increased efficiency on fan prices is accounted for in the impact assessment (price increase due to efficiency increase) because, with or without the Motor Regulation, the fans need to comply with the Fan Regulation anyway and fan manufacturers may opt for using higher efficiency motors to realise the savings that are required.

Considering that the motor measure is not of major influence on either the volume of fan sales, the distribution of these sales by fan types or the costs of these fans, that only a limited portion of overall fan savings may be due to improved fan motor efficiency and that stakeholders are not able to provide the necessary data to include a baseline scenario with a separate assessment of possible effects of a motor measure, this impact assessment does not include the possible effect of a motor measure in the baseline scenario. Certainly savings may be reached by employing more efficient motors in fans but these savings may also be reached without the measure for electric motors and through the proposed fan measure alone. Therefore this impact assessment provides a quantified estimate of the overlap in savings and suggests to deduct this overlap from the combined overall savings for fans and electric motors in 2020 in the case both measures for motors and fans come into effect (see also section 6.2).

5. IMPACT ANALYSIS

This assessment follows the criteria set out in Article 15(5) of the Ecodesign Directive, and includes impacts on manufacturers, including SMEs. The aim is to describe for each sub-option the associated environmental, economic and social impacts related to achieving compliance with ecodesign requirements, while avoiding negative impacts on industry's competitiveness and product functionality. The inputs of the analysis are given in Annex D.

This chapter compares the impacts of the various scenarios per aspect, i.e. regarding:

- Energy saving and security of supply;
- Greenhouse gas emission reduction;
- Customer economics and affordability;
- Business economics and competitiveness;
- Employment;
- Technology, functionality and innovation;
- Health, safety and other environmental aspects;
- Administrative burden.

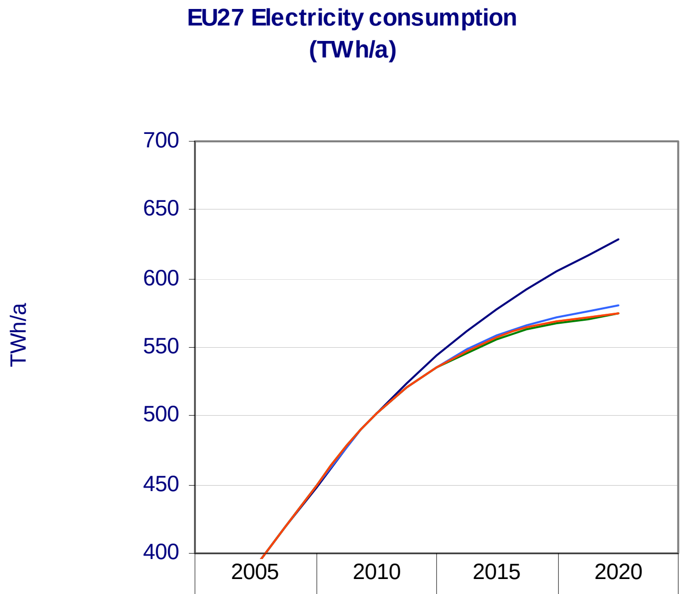
2.1 Energy saving and security of supply

The table and figure below shows the electricity consumption of BAU and four sub-options.

Table 5.1: Electricity consumption and savings (TWh/a, %)

TWh/a	2005	2010	2015	2020	2025	savings 2020	
BaU	390	502	578	629	683	ref	ref
A: CSWD	390	502	557	575	593	-53,5	-8,5%
B: Industry	390	502	558	580	601	-49,0	-7,8%
C: EnvNGO	390	502	556	574	592	-54,4	-8,7%
D: Compromise	390	502	557	575	592	-54,2	-8,6%

Figure 5.1: Electricity consumption



	2005	2010	2015	2020
BaU	390	502	578	629
A: CSWD	390	502	557	575
B: Industry	390	502	558	580
C: EnvNGO	390	502	556	574
D: Compromise	390	502	557	575

Sub-option A (based on CSWD) saves approximately 54 TWh by 2020 (8.5% savings compared to BAU). Sub-option B saves some 49 TWh/a by 2020 compared to BAU (7.8% savings). Sub-option C achieves 55 TWh/a or 8.7% savings compared to BAU (when rounded to the first decimal, sub-option 3 saves 0,9 TWh/a more than sub-option 1). Sub-option D, saves approximately the same as sub-option 1 and 3: 54 TWh/a or 8.6% savings.

The EU27 electricity demand in 2005 was 3106 TWh/a including the energy sector (incl. distribution losses). Net final demand excl. the energy sector was ca. 2755 TWh/a, of which industry 40,9% (1127 TWh/yr) and the tertiary sector 27,4% (755 TWh/yr) [23]. Thus fans represent approximately 15% of the 2755 TWh/a.

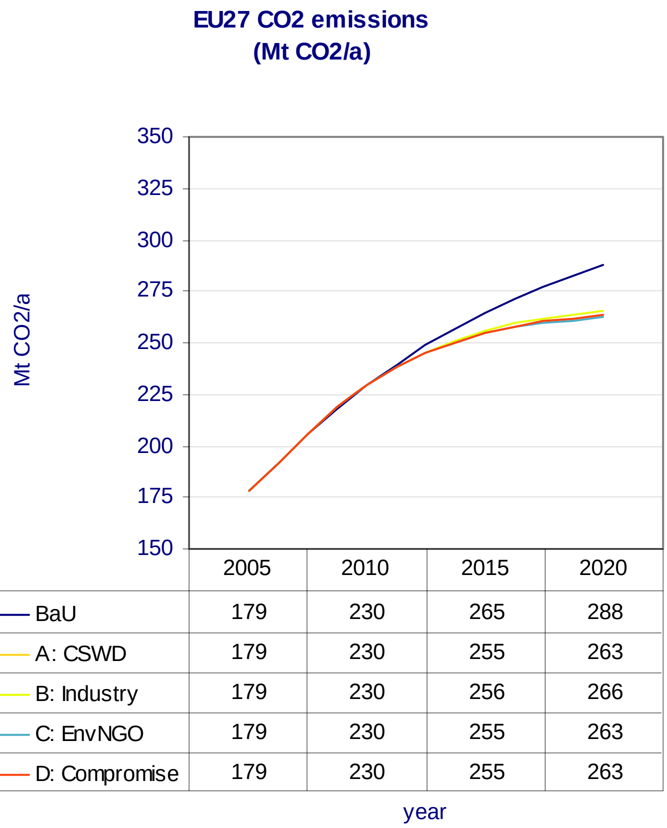
Impacts at the level of primary energy are presented in Annex F.

[23] To complete : Households 29% (799 TWh/a) and transport 2,7% (74 TWh/a)

5.2 Greenhouse gas emission reduction

Greenhouse gas emissions and savings follow the same trend as electricity.

Figure 5.2: Greenhouse gas emissions



	2005	2010	2015	2020
BaU	179	230	265	288
A: CSWD	179	230	255	263
B: Industry	179	230	256	266
C: EnvNGO	179	230	255	263
D: Compromise	179	230	255	263

The BAU total of 179 Mt CO_2 eq. in 2005 is around 4,4% of the EU27 total of 4025 Mt CO_2 eq. in 2005 (source EEA). The BAU consumption is expected to increase towards some 288 million tons of CO2 in 2020, an increase of 60%. All sub-options will save 8% to 9% of the total emissions.

Table 5.2: Greenhouse gas emissions CO2/a

CO2	2005	2010	2015	2020	2025	savings 2020	
BaU	178,6	229,7	264,5	288,0	312,8	ref	ref
A: CSWD	178,6	230,1	255,0	263,5	271,7	-24,5	-8,5%
B: Industry	178,6	230,1	255,7	265,6	275,3	-22,4	-7,8%
C: EnvNGO	178,6	230,1	254,8	263,1	271,1	-24,9	-8,7%
D: Compromise	178,6	230,1	254,9	263,2	271,2	-24,8	-8,6%

5.3 Customer economics and affordability

The life cycle cost of a fan is decreasing in all sub-options. However, the implementation of minimum energy efficiency requirements will increase the customer purchase costs. The calculations are based on a fan life time of 15 years.

The lowest consumer expenditure over the life cycle of a fan is offered by sub-option C and D, at almost 100 billion Euro these options save some 7 billion in 2020 when compared to BAU (2.5% savings).

Figure 5.3: Customer expenditure LCC

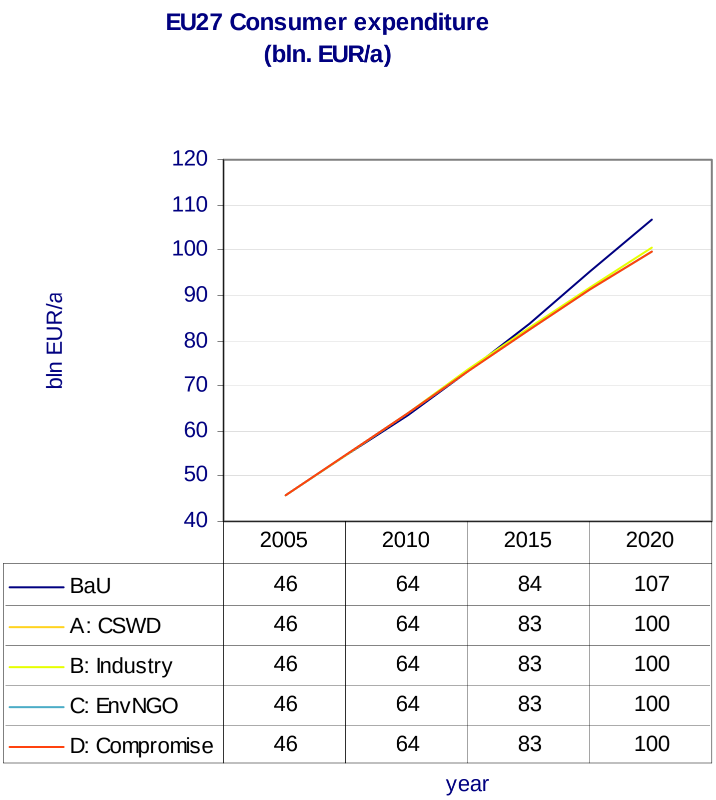


Table 5.3a: Consumer expenditure (total, including electricity)

Expenditure [bln]	2005	2010	2015	2020	2025	savings 2020	
BaU	45,6	63,6	83,8	106,8	137,5	ref	ref
A: CSWD	45,6	63,7	82,6	99,8	121,5	-7,0	-2,4%
B: Industry	45,6	63,7	82,7	100,3	122,9	-6,4	-2,2%
C: EnvNGO	45,6	63,7	82,6	99,7	121,3	-7,1	-2,5%
D: Compromise	45,6	63,7	82,6	99,7	121,4	-7,1	-2,5%

The purchase price of the average fan in the BAU is expected to decrease because of improved production efficiency. The minimum efficiency requirements will increase the average purchase price with approximately 16% to 18%.

Table 5.3b: Purchase price

Purchase price [EUR 2005]	2005	2010	2015	2020	2025	savings 2020	
BaU	861,6	841,0	837,2	833,4	829,5	ref	ref
A: CSWD	861,6	841,0	984,7	979,6	974,6	146,2	17,5%
B: Industry	861,6	841,0	968,9	964,0	959,1	130,6	15,7%
C: EnvNGO	861,6	841,0	986,8	982,1	977,3	148,7	17,8%
D: Compromise	861,6	841,0	986,6	981,6	976,6	148,2	17,8%

The savings in electricity consumption per fan are approximately 14 to 15%. The increase of purchase price is offset by the energy savings and the increase of the electricity price[24], resulting in lower overall life cycle costs of the sub-options.

[24] See assumptions in Annex D.

5.4 Business economics and competitiveness

The diagram below represents the outcome of the stock model as regards business revenues. The measures relating to the fan efficiency are expected to lead to an increase of up to 18.7% (sub-option A) with respect of BAU. In figures: An increase of ca. € 2.3 billion from € 12,2 to € 14,4 billion for the industry sector.

Figure 5.4: Turnover (excl. electricity sector)

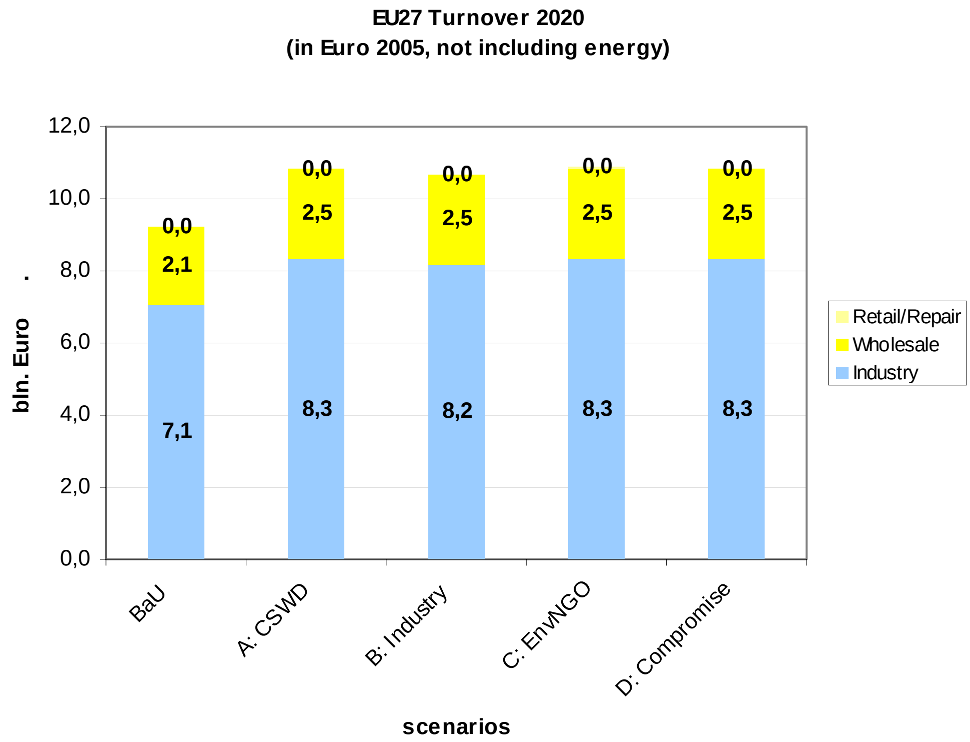


Table 5.4a: Turnover of related industry 2020 (excluding electricity sector, incl VAT)

Turnover	2005	2010	2015	2020	2025	savings 2020	
BaU	8,6	9,4	10,2	11,0	11,7	ref	ref
A: CSWD	8,6	9,4	12,0	12,9	13,8	1,9	17,5%
B: Industry	8,6	9,4	11,8	12,7	13,6	1,7	15,7%
C: EnvNGO	8,6	9,4	12,0	12,9	13,8	2,0	17,8%
D: Compromise	8,6	9,4	12,0	12,9	13,8	2,0	17,8%

The table below gives the turnover in 2020 by sector, including the electricity sector.

Table 5.4b: Turnover by sector (2020)

	BaU	A: CSWD	B: Industry	C: EnvNGO	D: Compromise
Industry	7,1	8,3	8,2	8,3	8,3
Wholesale	2,1	2,5	2,5	2,5	2,5
Retail/Repair	0,0	0,0	0,0	0,0	0,0
VAT prod	1,8	2,1	2,0	2,1	2,1
Total involved.	**11,0**	**12,9**	**12,7**	**12,9**	**12,9**
energy	98,5	90,1	90,9	90,0	90,0
Total	109,5	103,0	103,5	102,9	103,0

The industry related with fan production and sales can be roughly divided in two categories; those that produce fans and those that use fans in their products. The latter is represented mainly by Eurovent, in particular in ventilation and air-conditioning sectors, while fan producers are not represented in any European level Association, which makes the data gathering difficult (some fan producers can of course be members of Eurovent).

During the Impact assessment, fan producers, such as ebmpapst, Ziehl-Abegg, Helios, Nuaire, Soler i Palau, Nicotra-Gebhardt and Fläktwood, provided information for the impact assessment. The contacted fan producers estimated their share of total EU fan sales to about 80%. It is assumed that some 350 (+/-100) individual fan manufacturers exist in the EU[25], many of them probably SME sized. None of the fan manufacturers indicated any problems related to SMEs, mainly as fan manufacturers often produce a wide range of fan products, including products beyond the scope of the Regulation, which reduces the impact of the foreseen Regulation.

Some Member States are home to very large multinational fan manufacturers but these companies have facilities all over the EU and often also outside the EU and therefore should not be linked to a particular Member State. No information has been found or received from the industry that would allow the estimate of the share of the turnover by SMEs but it is assumed that some 20% of the fan manufacturers are responsible for abut 80% of the total turnover.

The additional R&D cost due to the foreseen Regulation are estimated minimal as the technology to comply with the measures exists on the market today and no new technology needs to be developed. Furthermore, improvement of motor efficiency is the likely first step

[25] This is based upon a statement by the UK Fan Manufacturers Association which says the UK holds some 94 individual fan manufacturing companies (includes companies using OEM fans for final fan products). Extrapolating this figure to the whole EU on the basis of GDP (UK GDP is 15% of EU GDP) gives almost 630 fan manufacturing companies for the EU. This impact assessment assumes that some 250 to 450 companies is probably closer to reality since the UK situation may not be typical for the whole EU.

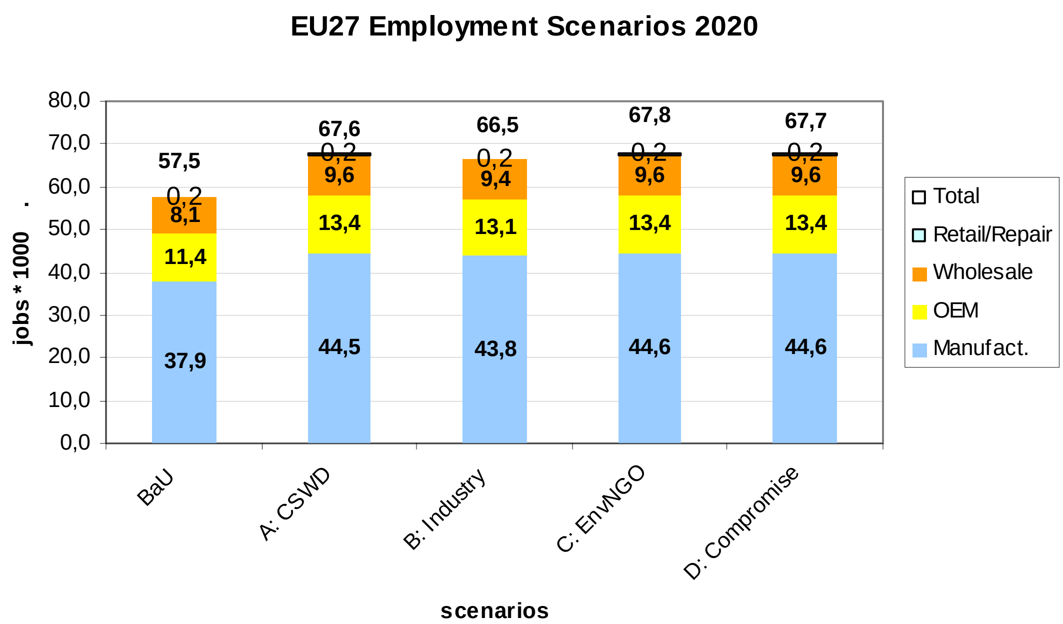
in improving fan efficiency for a large part of the fan market and this is already achieved partly through the forthcoming motor measures. It is estimated that some 21-25% of the fan population (based on data 2005) is affected by the fan measures, leaving 75-80% of the fan population without any need for improvement due to the measures (for the first stage only). The effects of the fan measures on SME's are therefore considered minimal (see also Chapter 5.5).

However, if there would be a small SME producing only poor efficiency fans and only within the scope of the foreseen Regulation, such a company could face heavy investment costs, if sufficient time would not be given for investments. However, the existence of such a company is estimated very small. In any case, if such a company would exist, it would already today be facing the competition from the imports by fan producers from low-wage countries outside the EU. No information has been received that would support the idea of small SMEs working on poor efficiency fans alone within the scope of the foreseen Regulation, which is supported by the fact that the European fan manufacturers strongly support the proposed Regulation, in particular to ensure level playing field against manufacturers that only import into the EU. However, due to missing data, some uncertainty remains on this issue, in particular as most of the fan producers contributing to this impact assessment are larger companies.

5.5 Employment

The figure below gives the results for impacts on employment.

Figure 5.5a: Employment according scenarios



The exact distribution of jobs within the manufacturing industry is not known, e.g. between R&D and processing; it is estimated that the share of jobs follows the average industrial distribution of jobs.

Employment is a function of total turnover of the fan industry, which in turn is a function of the sales and price development of the products. Sales (quantity) are driven by market demand. The price development is driven by (1) higher average product costs price due to higher average product efficiency (lower efficiency models are phased out) and (2) reduced product cost price due to increased production efficiency. Short term effects on employment are not expected, since only the least efficient models will be phased out in the first stage, which has a limited effect on sales (the outgoing models are easily replaced by models of average efficiency and average price). The long term effects are an increase of product turnover (more models sold with average or higher efficiency) with an indirect positive effect on employment as described above.

The table below gives the results for employment per sector. Some 9 to 10 thousand jobs can be created (based on turnover per employee 2005) for the sub-options, of which some 6 to 7 thousand are created at the manufacturers, including OEM suppliers. The exact distribution of jobs within the manufacturing industry is not known, e.g. between R&D and processing; it is estimated that the share of jobs follows the average industrial distribution of jobs.

As the potential impact of the foreseen fan measure on employment and industry, in particularly on SME's, can not be quantified, a qualitative assessment of possible constraints is made, based upon DG ENTR's SME Observatory study 2007 as follows.

The observatory of European SME's of DG ENTR in its 2007 Observatory study[26] concluded that the main difficulties of manufacturing SME's (all, not just fan manufacturing) are related to labour costs (38% responded affirmative) and lack of skilled labour (46% responded affirmative) and that 'implementing new technology' is not a main issue (only 18% responded affirmative). Almost half of the SME's feel that the regulations imposed upon SME's e.g. for the protection of the environment are appropriate (34%) or even not ambitious enough (14%). Some 63% of manufacturing SME's consider 'Single Market legislation including harmonised technical standards' to be rather or very important. If asked how SME's react if competition increases the most quoted answers are to 'increase product differentiation/ look for market niches' and to 'increase quality'.

Therefore it is assumed that introduction of ecodesign measures is most likely not a technological or financial problem for many SME's and may even be welcomed by many, but that the acquisition of skilled labour force could be a problem. This is not necessarily contradictory to the estimate above that the higher the overall costs are the higher the increase in employment.

Stakeholder consultation indicated that over 75% of fan sales are sales to OEM (Original Equipment Manufacturers) partners. The majority of these OEMs are manufacturers of end-use ventilation equipment and they are often SME sized. These SMEs buy their fans from large vendors (or manufacturers directly) and often put them in ventilation products that are made in series or for a specific client. Therefore it is safe to say that most of the "fan manufacturers" do not produce their own fans. The few SME fan manufacturers who produce their own fans operate mostly in niche-markets and do not serve the bulk of the market. The problem of SMEs to find skilled labour is a general problem (outcome of the SME observatory study) and not in particular aggravated by the proposed measures, as anecdotal evidence suggests that most SMEs in this sector are users of fans and/or fan components for specific applications and hardly the actors behind the research needed to develop new, improved fan models. In fact, the measures could very well be helpful to the SMEs as they

[26] http://ec.europa.eu/enterprise/enterprise_policy/analysis/observatory_en.htm

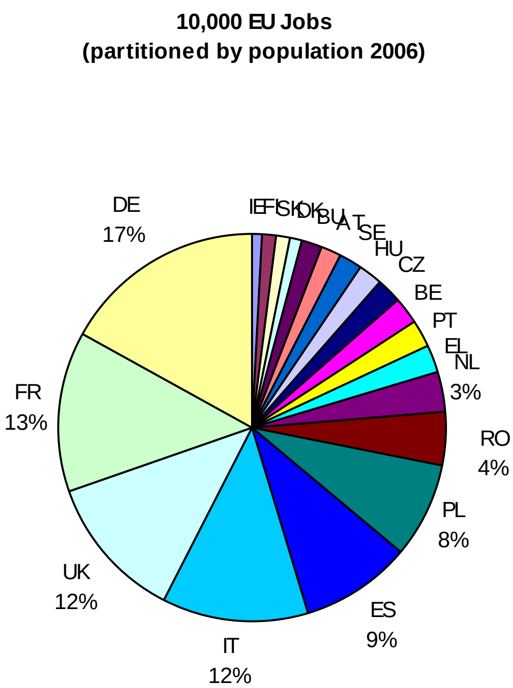
force the OEMs (i.e. the large fan producers) to produce a wide and affordable range of the high-efficiency fans that customers will require in tomorrow's world. Therefore almost all fans on sale in the EU are produced by multinationals from the EU (or from outside the EU). It is mainly these larger fan producers who are most directly affected by the proposed measures and not the majority of SME's who only source OEM fans.

The need for educated labour force is a broader phenomenon that cannot be discussed solely in the context of ecodesign measures for fans. The Lisbon Agenda has already highlighted this general problem and agreements have been reached to combat the problem. The ecodesign measures do not stand in the way of these agreements and rather help to reinforce them.

Table 5.5. Employment impacts per sector

	BaU	1:_/12/15	2:_/12/15	3:_/12/15	4:_/12/15
Manufact.	37,9	44,5	43,8	44,6	44,6
OEM	11,4	13,4	13,1	13,4	13,4
Wholesale	8,1	9,6	9,4	9,6	9,6
Retail/Repair	0,2	0,2	0,2	0,2	0,2
Total	57,5	67,6	66,5	67,8	67,7
extra jobs		10,1	9,0	10,3	10,2
of which SME's		4,9	4,3	4,9	3,0

Figure 5.5b: New jobs partitioned per Member State on the basis of population



5.6 Technology, functionality and innovation

High efficiency fans are a good option for most applications. There are however applications were the use of high efficiency fans may not be the best technical or economical choice: Especially in applications in which the number of operating hours is small (e.g. box fans and roof fans) high efficiency fans may lead to higher lifecycle costs (see Annex C).

5.7 Health and safety

No impacts of the considered sub-options on health or safety have been identified during the preparatory study or the impact assessment.

5.8 Administrative burden

The form of the proposed legislation is a Regulation, which is directly applicable in all Member States. Therefore there are no costs for national administrations due to the transposition of the implementing legislation into national legislation. The use of a Regulation also provides a level playing field for the industry, as the measure comes into force simultaneously in an identical form across all the Member States. Monitoring Costs will depend on the CE marking procedure: self declaration and ex-post control or declaration with third party approval.

With the entry into force of new requirements, manufacturers will need to adapt the design of products not complying with the new requirements. This in general implies the need for re-assessing the conformity of existing products with the legal requirements. The conformity assessment is usually part of the normal internal design control of the manufacturer (or management system as in Annex V of the Directive) to ensure that the product will meet the legal requirements. Only in exceptional case (to be justified as laid down in Annex VII of the Directive) can the implementing measure require third party testing. The cost of assessing conformity of fans is small as virtually all the necessary information is already produced as a part of standard measurements for catalogue data and CE-marking. The energy efficiency value for a specific fan can be calculated if the best efficiency point of the specific fan is known, which usually is the case. This is why the use of the EU Standard Cost Model on administrative burden has not been considered necessary in the case of fans.

5.9 Impact on trade

The process for establishing Ecodesign requirements for fans is transparent. Before the proposed Regulation is adopted by the Commission a notification under WTO-TBT[27] will be issued. Competitive disadvantages for EU manufacturers exporting affected products to third countries are not expected due to the fact that most EU fan manufacturers produce for the EU market.

Competitive disadvantages for EU manufacturers exporting fans to third countries or for non-EU manufacturers importing fans are not expected; all manufacturers will have to comply with the Regulation on an equal basis. No such disadvantages are known to exist either due to the minimum requirements on fans in China. Although the fan market is global in nature, most EU fan manufacturers produce mainly for the EU market.

The preparatory study shows that manufacturers inside the European Union are well known for the quality and efficiency of their products. They are serving not only the European but the international market. Fan extra EU imports range from 4% of total imported value for centrifugal fans to 23-30% for axial and other fan types. Fan extra EU exports are some 30-40% of total EU exports (which includes intra EU exports).

[27] The Technical Barriers to Trade Agreement under the World Trade Organisation aims at ensuring that regulations, standards, testing and certification procedures do not create unnecessary obstacles.

The studies did not identify a more efficient fan market outside the EU. Instead cheap but low efficient products produced in countries such as e.g. China which are entering the European market tend to lower the efficiency levels. Products from the low-wage countries are typically not designed using CFD to optimise blades, using low efficient AC motors and often simple straight sheet metal blades. So these products can not help to increase efficiency of the products but instead are lowering the average efficiencies as they are imported and used in Europe due to their highly competitive price in first cost.

The combined turnover of all fan sales together for all sectors involved (excluding energy sector and VAT) is almost 8 billion (2005). Exact numbers are not given in the preparatory study but it is assumed that some 350 (+/-100) individual fan manufacturers exist in the EU[28], most of them probably SME sized. Some Member States are home to very large multinational fan manufacturers such as ebmpapst in Germany, Soler i Palau in Spain, Nicotra in Italy, Fläktwood in the UK, but these companies have facilities all over the EU and often also outside the EU and therefore should not be linked to a particular Member State.

No more precise information is available on the exports and imports of individual manufacturers or 'Member States', nor for EU export and imports, despite of more than two years of serious attempts under the preparatory study and the impact assessment. This is mainly due to the reluctance of individual manufacturers to reveal this information that is considered sensitive. The fan market is highly competitive, as stated in the preparatory study, and therefore manufacturers are not willing to disclose the kind of improvements they are working on.

5.10 Sensitivities considered

Sensitivities are considered for two variables:

- increased product price per cut off level;
- decreased electricity price.

All analyses are performed for the year 2020.

The impact of ecodesign requirements on the affordability of products would in principle require an assessment of income structure of the users of fans. The purchase cost increases against the life cycle cost reduction of fans in the light of the proposed policy measure, as shown in the below table. The tables below show also the impacts, if the electricity price is reduced.

In the reference situation the discount rate payback[29] is used as indicator in the following table. The payback times are adapted in accordance with a 4% discount rate.

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28 This is based upon a statement by the UK Fan Manufacturers Association which says the UK holds some 94 individual fan manufacturing companies. Extrapolating this figure to the whole EU on the basis of GDP (UK GDP is 15% of EU GDP) gives almost 630 fan manufacturing companies for the EU. This impact assessment assumes that some 250 to 450 companies is probably closer to reality since the UK situation may not be typical for the whole EU.

29 As described in Annexes to Impact Assessment Guidelines, 15 Januar 2009

Table 5.10: Total expenditure/GHGemissions for year 2020

	Expenditure/GHG Emissions 2020 by sub-option				
Parameters	**BAU**	**Sub-option A**	**Sub-option B**	**Sub-option C**	**Sub-option D**
Higher purchase price increase per efficiency point	Expenditure [bln. Euro/a]				
original parameter: purchase price increase per efficiency point: 28 Euro/%)	106.8	99.8	100.3	99.7	99.7
changed parameter: purchase price increase per efficiency point: 56,3 Euro/%	106.7	101.0	101.4	100.9	100.9
Lower electricity price	Expenditure [bln. Euro/a]				
original parameter: electricity price: 0,087 Euro/kWh at 4% annual price increase	106.8	99.8	100.3	99.7	99.7
changed parameter: electricity price: 0,065 Euro/kWh at 4% increase per year	81.9	77.0	77.4	76.9	76.9
changed parameter: electricity price: 0.065 Euro/kWh at 0% price increase per year	49.1	47	47.2	47.0	47.0
Lower GHG emission per kWh	GHG [Mt CO2 eq./a]				
original parameter: CO_2 emissions: 0.458 kgCO2 eq/kWh	288	263	266	263	263
	ref.	-8.5%	-7.8%	-8.7%	-8.6%
changed parameter: CO2 emissions: 0.384kg CO2eq/kWh (from: trends to 2030, for year 2010-2020)	241	221	223	221	221

An increase of the product price (fan is more expensive per percentage point efficiency increase) has a slight increase on the overall expenditure. The overall conclusions remain the same: Sub-option C and D show the largest savings on total expenditure. The increase of product price per efficiency point needs to be at least five times as large (at 140 euro/%) as calculated in the Impact Assessment in order to minimise the differences between the sub-options and reduces the savings to maximum 0,5% (not shown in table). Beyond six times the calculated efficiency increase price (197 EUR/%) the savings will become negative (expenditure increases) (not shown in table).

A reduction of the annual price increase of electricity (original value 4%/a) will reduce the overall expenditure, but will also make the savings of more efficient fans less economically viable. In the table above one can conclude that halving the electricity increase rate to 2%/a still results in the same overall conclusions: Sub-option C and D show the largest savings on total expenditure. Even if the electricity prices remain at the 2005 value there will be savings on expenditure by 2020 (max 1,2%) (not shown in table).

6. COMPARE OPTIONS

Due to the potential overlap between the draft Motor Regulation and the foreseen Fan Regulation, this chapter compares the analysed sub-options and discusses the overlap.

6.1 Comparison of main impacts

The table below give an overview of net impacts of sub-options.

Table 6.1a: Main impacts 2020

MAIN IMPACTS							
			Scenario's 2020				
			1	2	3	4	5
IMPACTS (as Art. 15, sub. 4., subsub e. of 2005/32/EC)			**BaU**	**A: CSWD**	**B: Industry**	**C: EnvNGO**	**D: Compromise**
ENVIRONMENT							
	ENERGY	PJprimary/a	**5659**	**5178**	**5219**	**5170**	**5172**
	GHG	Mt CO2 eq./a	**288**	**263**	**266**	**263**	**263**
	Electricity	TWh/a	**629**	**575**	**580**	**574**	**575**
CUSTOMER							
EU totals	expenditure	€ bln./a***	**106,8**	**99,8**	**100,3**	**99,7**	**99,7**
	purchase costs	€ bln./a	8,3	9,6	9,5	9,7	9,7
	running costs	€ bln./a	98,5	90,1	90,9	90,0	90,0
per product	product price	€	833	980	964	982	982
	install cost	€	52	52	52	52	52
	energy costs	€ /a	434	372	377	371	371
	payback (discount rate corr.)	years	reference	**3,2**	**3,1**	**3,2**	**3,2**
BUSINESS							
EU turnover	manuf	€ bln./a	**7,1**	**8,3**	**8,2**	**8,3**	**8,3**
	whole-sale	€ bln./a	**2,1**	**2,5**	**2,5**	**2,5**	**2,5**
	instal	€ bln./a	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**
EMPLOYMENT							
employ-ment (jobs)	industry EU (incl OEM)	'000	47	55	54	55	55
	industry non-EU	'000	2	3	3	3	3
	whole-sale	'000	8	10	9	10	10
	installers	'000	0	0	0	0	0
	TOTAL	'000	**58**	**68**	**67**	**68**	**68**
	of which EU	'000	55	65	64	65	65
	EXTRA EU jobs	'000	reference	**9,7**	**8,7**	**9,9**	**9,8**
	of which SME**		reference	4,9	4,3	4,9	3,0
**= partitioning 50% industry & wholesale, 80% installers							
***=all money amounts in Euro 2005 (inflation corrected)							

The table below give an overview of boundary conditions. While reading the table, it is important to note the variations in impacts between sub-options are very small, except as to the potential very negative impacts from phasing out one technology and the impact on industry. Accordingly, the difference in the number of plusses assigned for each impact must be seen more as an indication of the hierarchy of savings between sub-options based on sometimes minuscule absolute differences.

Table 6.1b: Boundary conditions

BOUNDARY CONDITIONS ("should be no negative impacts")					
	Scenario's 2020/ 2025				
IMPACTS "No negative impacts" following Art. 15, sub 5 of 2005/32/EC	**BAU**	**1:_/12/15**	**2:_/12/15**	**3:_/12/15**	**4:_/12/15**
Economic	-	++	+	++	++
Social	-	++	+	++	++
Environmental	-	++	+	++	++(+)
Industry	-	+	+	- (phase out cross flow)	++

Although the differences between sub-options are minor, following can be stated. The economic impacts of sub-option C are the highest in terms of overall expenditure (least savings). The highest savings on expenditure are given by sub-option C and D. The social impacts of the sub-options are very close together, with sub-option B giving the least number of extra jobs. The most jobs are generated by sub-option C and D. The reduction of environmental impacts are equal for sub-option C and D.

The impacts on industry are considered negative for sub-option C, since the drastic increase in minimum efficiency requirement will most likely phase out the cross-flow fan (doubling of average efficiency as minimum requirement). Phasing out cross flow fans would require a drastic redesign of the products in which they are used (e.g. fan-coil units or air-curtains). Considering the insignificant savings[30] from the phasing out cross-flow fans, it would be unreasonable to generate such an impact. Additionally, the fan types that would have to replace cross-flow fans would also risk operating outside their best efficiency point, which would lead to higher energy consumption.

Therefore, sub-option D gives the best balance of savings and costs identified.

This would provide the appropriate balance between an improved environmental impact of fans, including technical feasibility, and cost benefits for the end user (due to reduced electricity consumption), on the one hand, and possible additional burdens for manufacturers (in particular due to unplanned re-design) on the other hand. In particular:

- cost-effective reduction of electricity losses of fans;
- a payback time of approximately 3 years ensures that the requirements are affordable to the end-users;
- alleviation of existing of market failures and proper functioning of the internal market;

[30] These fans represent 0,5% of the overall energy consumption of the fans considered.

- no significant administrative burdens for manufacturers or retailers;
- slightly increased purchase cost, which would be fully compensated by savings during the use-phase of the product;
- possibly decreased purchase cost medium-term, when the impact of economies of scale for effective technologies takes place;
- that the specific mandate of the Legislator is respected;
- reduction of the electricity consumption of about 54 TWh/a, corresponding to savings of 7 billion EUR and 25 Mt of CO_2 by 2020 compared to the "no action" (BAU) option. The electricity consumption saved corresponds approximately to the annual electricity consumption of Greece in 2006;
- a clear legal framework for product design which leaves flexibility for manufacturers to achieve the energy efficiency levels of the second tier already before the coming into force of the second requirement;
- costs for re-design and re-assessment upon introduction of the regulation, which are limited in absolute terms, and not significant in relative terms (per product);
- fair competition by creation of a level playing field;
- the impacts on the competitiveness, and in particular for SMEs, of industry appear limited as no single technology is excluded (phased out), and due to the fact that several manufacturers already manufacture high-efficiency fans and a host of other products used in fan systems;
- no negative impact on employment;
- no identified impact on trade.

6.2 Overlap with the draft Motor Regulation

As explained above, there is no overlap with any other EuP product group than a partial overlap with the draft Motor Regulation, if it would come into force. The foreseen savings from the fan measure will be realised independently of the coming into force of the draft Motor Regulation. If the draft Motor Regulation comes into force, the overlap must be taken into account as follows.

Of the total energy consumption of fans in the range 0.125-500 kW some 80% is consumed by fans that are within the scope of the draft Motor Regulation (above 0.75 kW).

Table 6.2: Share in total electricity consumption of fans above 0,75 kW.

Fan type	base case power	below 0,75 kW	above 0,75 kW	% of sales	% of overall electr.cons.
Axial	1.08	partly	partly	40%	34%
Centr.FC	0,44	x		9%	5%
Centr.BC-free	3,76		x	3%	12%
Centr.BC	3,82		x	3%	13%
Cross-flow	0,42	x		1%	0,5%
Box	0,37	x		18%	5%
Roof_all	1,2		x	27%	32%
below 0,75 kW				47%	21%
above 0,75 kW				53%	79%

It is estimated that the total savings of fans from 125 W to 500 kW are approximately 54 TWh in 2020 (rounded average of the sub-options 1, 3 and 4). The savings of fans above 0.75 kW are estimated to be a proportional 80% of this total (43 TWh). However, not all of the 43 TWh savings are overlapping with the draft Motor Regulation.

Stakeholders have estimated that some 26% of fans above 0,75 kW are fans sold without motors (just the impeller fan). Since the efficiency of these fans is calculated on the basis of a default IE1 motor efficiency, the draft Motor Regulation would have no direct effect on fans achieving the required fan efficiency. Therefore all savings will stem from increased fan efficiency by other means than increased motor efficiency and the savings do not constitute an overlap with the savings of the draft Motor Regulation for these type of fans (impeller fan only).

The savings are assumed to be proportional to the share in the total consumption of fans above 0,75 kW, being 26% of the total savings of 43 TWh, that is 11 TWh in 2020. Additional savings may be achieved once these fans are combined with more efficient motors when they are put into service, but these savings are covered by the motor measure and do not constitute an overlap with the fan measures. .

The remaining 32 TWh savings (43 TWh minus 11 TWh gives 32 TWh) are delivered by fans sold with a motor and therefore increased motor efficiency directly impacts the efficiency an savings of this type of fans (fans sold with a motor). This category of 'motorised fans' covers fans with direct drive and integrated motors of which only a fraction are induction motors. Motors applied by many fans but not covered by the motor measure are for example shaded pole, EC and/or permanent magnet motors. Hard data on the actual number of fans with non-induction motors however does not exist. Estimates by industry suggest that about half of these fans do not use induction motors. Thus, the overlap with the draft Motor Regulation is about half of the 32 TWhs, being then approximately 16 TWh/a.

For the calculation of fan efficiency the impact assessment assumes a default motor efficiency IE1, which ranges from 79% to 85% at base case power. The first stage of the efficiency requirement of the draft Motor Regulation would change this default motor efficiency in 2011 to IE2 which results in an increase of motor efficiency by some 5%. Since the motor losses are only a part of the overall losses of the fan product (the impeller losses are generally higher) the contribution of improved motor efficiency to the overall fan efficiency is estimated to be around 2,5%.

The second increase in motor efficiency in 2015 applies to motors above 7,5 kW. It is estimated that about 1/3 of the motors in this range will be improved to level IE3 (about two thirds of the motors will remain IE2, based on the impact assessment on motors).

Since most fans are below the 7,5 kW, the draft Motor Regulation would have only a modest effect on the total savings by fans. However the proposed second stage of the fan measures also comes into force in 2015 and fan manufacturers can opt to either apply more efficient motors to fulfill the measures or to improve other fan efficiency aspects. Since the third stage requirements of the draft Motor Regulation come into effect in 2017 and will affect most of the fan population (increasing IE2 levels to IE3 levels for 1/3 of the fan motors) it is to be expected that the fan measure of 2015 will also, at least partially, be achieved by an increase of motor efficiency.

Based on the above, it is estimated that out of the remaining 16 TWh possible overlap some 75% (the complete first stage and partially second stage of fan measures) is due to improved motor efficiency stemming from the motor measures in 2011, 2015 and 2017. This results in an overlap of fan savings and motor savings of about 12 TWh by 2020 (0.75 * 16 TWh).

The overlap of 12 TWh represents some 22% of the total savings of the foreseen fan measure, if it delivered savings of about 54 TWh by 2020. When presenting the combined savings of both the motor and the fan measures, this 12 TWh must be deducted from the combined total savings (in practice, from the measure that introduces requirements later in time).

In summary, if the draft Motor Regulation comes into force, the estimated savings are about 22% lower than calculated in this impact assessment (provided that the requirements of the draft Motor Regulation come into force before the fan requirements). Pragmatically, it is assumed that changes in turnover, employment or other impacts are of the same relative size.

7. MONITORING AND EVALUATION

The main monitoring element will be the tests carried out for new product conformity. Products placed on the Community market have to comply with the requirements set by the proposed regulation, as expressed by the CE marking. Monitoring of the impacts is mainly done by market surveillance carried out by Member State authorities ensuring that the requirements are met.

The appropriateness of scope, definitions and concepts will be monitored by the ongoing dialogue with stakeholders and Member States. Input is also expected from work carried out in the context of upcoming Ecodesign activities on further product categories, and related activities.

The main issues for a possible revision of the proposed regulation are

– the appropriateness of the levels for the specific Ecodesign requirements;

– the appropriateness of the product scope.

Taking into account the time necessary for collecting, analysing and complementing the data and experiences in order to properly assess the technological progress, a review can be presented to the Consultation Forum no later than seven years after entry into force of the regulation.

ANNEX A: Minutes of meeting Consultation Forum

DRAFT SUMMARY MINUTES

Possible Ecodesign Implementing Measures on Fans 125 W – 500 kW under the Directive on the Ecodesign of Energy-Using Products (2005/32/EC)

Seventh meeting of the Ecodesign Consultation Forum (27th May 2008)

Charlemagne (CHAR), Alcide de Gasperi (S3) Room, Rue de la Loi 170, 1049 Brussels

EC Participants:

André BRISAER (Chairman)
Ismo GRÖNROOS-SAIKKALA (TREN/D3)
Villo LELKES (TREN/D3)
Ludmila MAJLATHOVA (ENV/C5)

Introduction

The Chairman welcomed the group and introduced Mr. Peter Radgen who was responsible for the technical study. The agenda was discussed and adopted.

The draft minutes of the 4th Consultation Forum from February 22nd were amended based on stakeholder input and approved.

Commission services presented the current proposal as in the Commission Staff Working Document (see presentation circulated together with these draft minutes) on possible ecodesign requirements for standalone glandless circulators available on

http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm#consultation_forum).

Presentation by Bill Cory on the proposed new ISO Standard ISO/TC117

Mr Cory presented the proposed ISO standard (ISO/TC 117 Energy Efficiency), which looks at having 4 fan categories and will likely grade according to size. The ISO would measure efficiency based on total fan efficiency. The ISO standard could be very helpful as the fan industry is a global industry and it is expected e.g. that new minimum efficiency requirements for fans will be set in the US. It was agreed that the role of the proposed ISO standard be assessed when it is adopted.

Main issues discussed:

EPEE was unsure of the scope of the foreseen implementing measure and how "put on the market" is defined in terms of a business to business parts intended for integration in appliances. Commission services explained that the scope covers all fans put on the market, also when put on the market for integration in an appliance. EPEE also queried whether heat recovery ventilation system fans have to comply and it was clarified that just the fan covered by the implementing measure must comply, not the whole system.

ECOS (representing the Environmental NGOs) asked why the requirements do not address Variable Speed Drives (VSDs). Mr. Radgen explained that if a consumer needs a single speed fan in full load condition, a VSD would only increase energy consumption; the cost-effectiveness of VSDs very much depends on the application where they are used. Netherlands asked if fans delivered with an integrated VSD are covered. They are.

Austria commented that the study recommended that an internet-based standardised database is established.

The Netherlands commented that 2020 is too far away for the introduction of measures and that 2015 is more realistic. ECOS supported, also because the least life cycle cost levels were determined two years ago in the preparatory study.

The Chairman agreed that the aim should be at the least life cycle cost level and considered 2015 a realistic.

ECOS made the point that there are different technologies for how air-flow is maintained. To keep the eight fan categories separate until 2020 as proposed in the working document is too low an ambition because these categories do not compete for higher efficiencies amongst themselves. The 8 categories should be simplified into the three major air moving technologies. Their testing condition should be clarified (inlet and outlet). Their target values in the third tier should merge at the level of the highest values of the 8 category scheme. Larger fans above 10 until 500 kW should have higher efficiencies (at least in parallel with the increase of efficiency in motors). ECOS suggested coordinating the introductory dates with other Lot 11 implementing measures with the last tier introduced in 2015.

Commission services agreed that in principle, coordinating the introductory dates would be desirable and be done if not inappropriate or unfeasible. Commission services also agreed merging the categories as far as feasible is a sensible and pragmatic approach towards removing barriers between technologies. It has to be seen how far categories can be clarified and their number reduced already for this implementing measure.

EBM-PAPST questioned the wording in the scope, which should read 'fans' and not 'ventilation fans'. It should not matter whether fans are box fans or roof fans because these are products with several components; manufacturers do not always know what end product their component will be in. Industry needs two years transition from the announcement of the minimum requirements and feel that 2020 is too far away to regulate. Industry would like to see requirements for relative improvements (i.e. 5 % higher) from 2015 or 2017. Industry agrees with the levels proposed but not the categories. The Commission invited EMB-PAPST to send comments on wording and suggested ways to combine the categories. DEFRA asked if it was expected that requirements would change if re-categorisation goes through. Re-categorisation should have minimum impact on the level of requirements.

VDMA commented that Germany has agreed to start a standardisation project with ISO but it will take 3 - 5 years. For this reason, the EU should not wait for a new standard. German industry is happy with Lot 11 approach.

Denmark recommends measuring both static and total (dynamic) efficiency. Bill Cory cautioned that measuring static efficiency the fan ducting needs to be taken into account. However this could be solved by fixing that measurements should be made only with inlet duct, an arrangement defined in the ISO 5801 standard. ECOS stated that the two issues arising from Bill Cory's presentation were the difference between total and static efficiency and also how to grade, either by referring to the electrical input power or the diameter of a wheel. Peter Radgen commented that EuP focuses on products and that it is misleading to use total efficiency, as the design looks at the static pressure to overcome the pressure losses in the ducting. The dynamic part is typically lost in the application. The role of the proposed ISO standard will have to be considered when it comes out (either before or after the introductory of the proposed measures).

Eceee asked for possibilities for energy labelling. The Chairman replied that this would be looked at under the extended scope of the revised 92/75/EEC energy labelling Directive.

Belgium asked about other parameters and whether RoHS and WEEE were applicable. The Chairman and Peter Radgen explained that fans comply with RoHS and WEEE. No hazardous substances are present which keeps fans out of scope of RoHS. The Chairman invited any suggestions for an information requirement which would facilitate the implementation of WEEE.

End of summary minutes

ANNEX B: Fan efficiency and improvement potential

Fan curves and efficiency

ISO 5801 is the international standard for assessment of performance of industrial fans. An important element is the definition of standard airways (ducts) which allows fans to be tested with harmonised test set-ups.

Categories of installation

Since the connection of a duct to a fan outlet and/or inlet modifies its performance, the standard recognises four standard installation categories:

A = free inlet, free outlet

B = free inlet, ducted outlet

C= ducted inlet, free outlet

D= ducted inlet, ducted outlet.

A fan adaptable to more than one installation category will have more than one standardized performance characteristic. Users should select the installation category closest to their application.

Fan efficiency

The efficiency of a fan is the product of airflow (m3/hr) and fan pressure (Pa) divided by the required power input (kW).

Fan pressure is defined as the difference between the stagnation pressure at the outlet of the fan and the stagnation pressure at the inlet of the fan. Two types of fan pressure can be measured: static fan pressure and total fan pressure. The latter pressure includes the pressure from air velocity (dynamic pressure) and is always larger than static pressure.

By measuring fan pressure at various flow rates a fan curve (pressure vs. flow rate) can be plotted. By measuring the input power at these multiple flow rates an efficiency curve for that specific fan (and speed) can be plotted and the maximum efficiency (Best Efficiency Point BEP) can be determined.

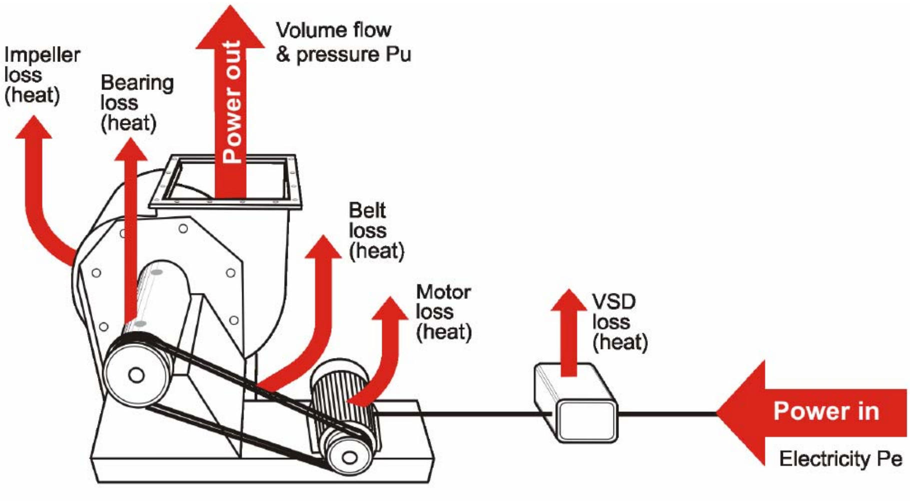
The input power can be given as the impeller power, shaft power, motor output power or motor input power. Hence, if efficiency is stated the type of test installation category (A, B C or D), type of pressure (static or total) and input power (impeller, shaft, output or input) must be indicated as well.

The preparatory study only considered static efficiency. The fan efficiency levels in this impact assessment are therefore based on static pressure unless indicated otherwise.

Losses

The losses (1-efficiency) are found in various components: the impeller itself, bearing losses, belt losses, motor losses, variable speed drive losses.

Figure B.1: Fan losses (centrifugal fan)

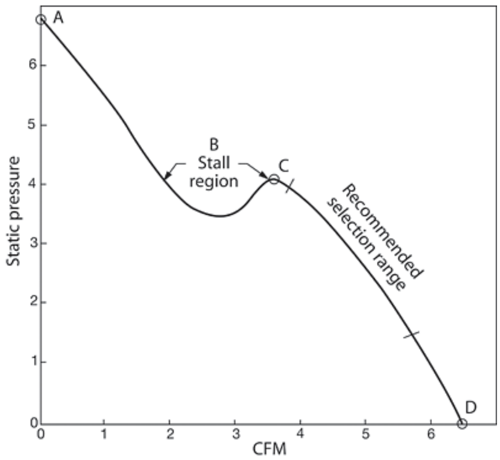


Fan curve

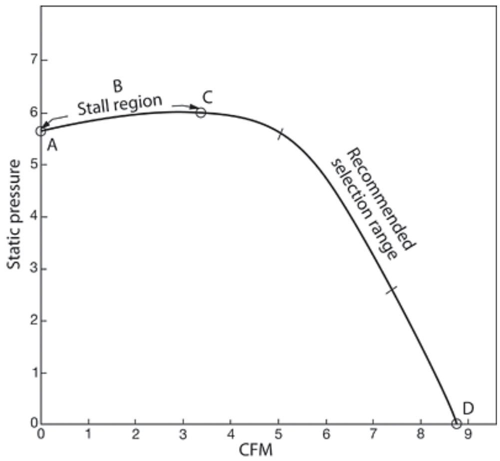
The performance of a fan is usually presented by a fan curve, which plots the pressure versus airflow. Below the ‘typical’ fan curves of axial and centrifugal fans is given.

Figure B.2: Typical fan curves for axial and centrifugal fans

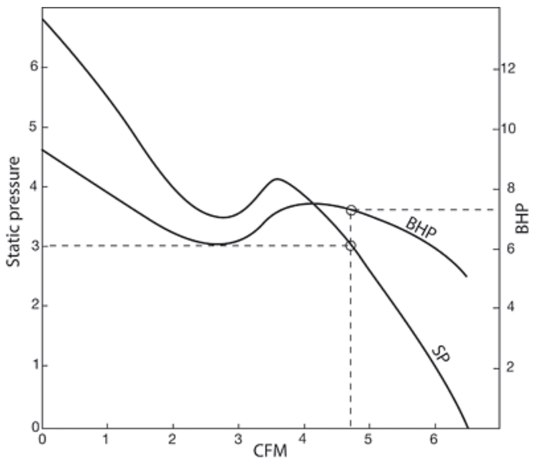
Axial fans



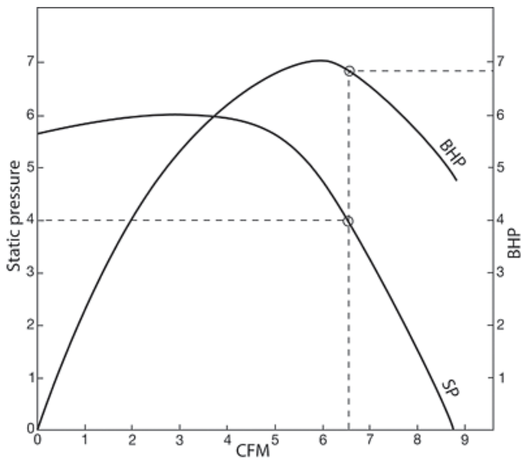
Centrifugal fans



flow vs. pressure



flow vs. pressure



flow vs. power

Each operating point of a fan lies both on the fan curve and the system curve. Where both curves intersect is the operating point. Usually the operating point is at the right from the best efficiency point (more stable operation).

Figure B.3: Fan curve and system curve (for axial fans)

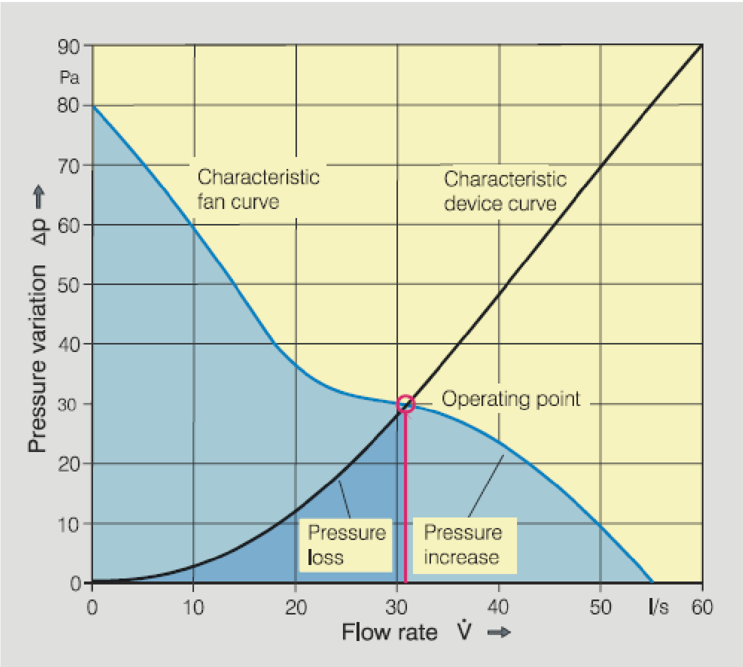
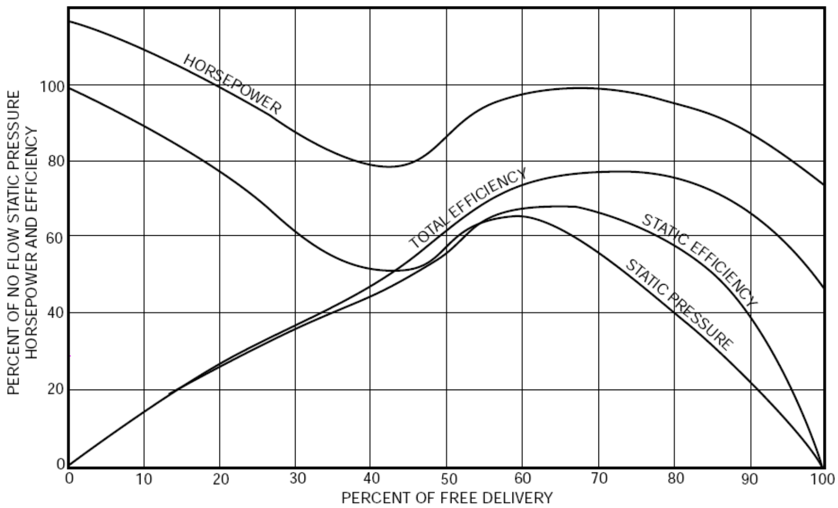


Figure B.4: Fan curve and efficiency (for axial fans)



When plotting fan efficiency against power input a logarithmic curve appears (levelling of to a constant value at increasing power input) with the log-formula of this curve being dependent on the typical fan (sub) category. So for different fan categories different logarithmic curves exist, describing typical fan efficiency.

CSWD Efficiency formulas

The preparatory study applied the following formulas for calculating minimum efficiency values for fans of size 0,125 kW to 500 kW. Roof fans with axial fans inside are based upon low pressure axial fans.

Table B.1: CSWD minimum efficiency formulas

Fan category	min.efficiency (%) by implementation date (static pressure)				
	2010 stage 1		2011 stage 1a	2012 stage 2	2020 stage 3
Axial, ≤ 300 Pa	3.42*Ln(Pe) +27.12	max: 35			as 2012 +4
Axial, > 300 Pa	2.28*Ln(Pe) +29.75	max: 35			as 2012 +4
Centrifugal / FC	2.74*Ln(Pe) +28.69	max: 35			as 2012 +4
Centrifugal / plug	4.68*Ln(Pe) +47.23	max: 58			as 2012 +4
Centrifugal / BC-AF	4.56*Ln(Pe) +44.49	max: 55			as 2012 +5
Cross flow fans	11.73*Ln(Pe) +8	min: 8 > 10 kW: 35	as Centr. FC	as 2011	as 2012 +4
Box fans	7.53*Ln(Pe) +25.66	max: 43		min: 20	as 2012 +4
Roof fans	3.42*Ln(Pe) +37.12	max: 45		3.26*Ln(Pe) +37.5	as 2012 +4

For fans of base case power the following minimum efficiency values apply.

Table B.2: Average efficiency and CSWD minimum efficiency requirements (at base case power)

Fan category	kW	avg. efficiency	2010	2011	2012	2020
Axial, ≤ 300 Pa	0,8	30,9%	26,4	26,4	26,4	30,4
Axial, > 300 Pa	1,32	37,1%	30,4	30,4	30,4	34,4
Centrifugal / FC	0,44	32,1%	26,4	26,4	26,4	30,4
Centrifugal / plug	3,76	56,4%	53,4	53,4	53,4	57,4
Centrifugal / BC-AF	3,82	53,7%	50,6	50,6	50,6	55,6
Cross flow fans	0,42	7,3%	8,0	26,3	26,3	30,3
Box fans	0,37	23,1%	18,2	18,2	18,2	22,2
Roof fans	1,2	43,6%	37,7	37,7	38,1	42,1

ISO 12759 FMEG lines

ISO 12759 is a forthcoming standard that provides guidance in expressing the efficiency of fans, by applying a grade to efficiency classes. Each fan can have its efficiency expressed by an absolute number (FMEG value for driven fans) that indicates the efficiency grade or class of this fan. FMEG stands for Fan-Motor-Efficiency-Grade and applies to 'driven' fans. Efficiencies of bare shaft fans can be calculated using default values for motor and transmission efficiency described in ISO 12759.

What the preparatory study did not fully describe is the relationship of installation categories, type of pressure measured and resulting fan efficiency.

The preparatory study referred to axial fans with (static) pressure development of less than 300 Pa and higher than 300 Pa. Fan industry consulted during the IA has responded that this split up based on pressure is not practical and the category of installation of the fan is of more importance. For axial fans there are two major installation categories:

1. ductless (ISO 5801 installation Cat. A) for wall or partition fans, where there are no ducts used for the inlet or outlet. Such fans deliver low pressure so that static pressure is adequate for expressing efficiency.

2. fully ducted (ISO 5801 installation Cat. D), where axial fans are placed in a tubular housing with connections for ducts at the inlet and outlet. Such fans are called tube-axial (or vane-axial if the product is equipped with guide fans) and are designed to deliver higher air pressures. Because some of the air velocity can be converted to useful pressure, the total pressure is suitable for expressing efficiency.

The other fan types are usually also applicable in more than one installation category. Depending on the combination of installation category and type of fan either static or total pressure is the preferred parameter, although within ISO there are still discussions ongoing which pressure best represents expected efficiency of fans. Static efficiency is generally preferred in applications where air velocity cannot be recouped (as in partition wall fans and box fans). Total efficiency is by some preferred for those applications where air speed is converted to useful pressure (such as tube-axial fans in ducted systems).

Furthermore ISO 12759 defines log-formulas for describing efficiency grades across the range of power input (from 0,125 kW to 500 kW).

Table B.3: ISO 12759 (latest version May 2009) proposed fan efficiency formulas for FMEG grading

Fan type	Category	Pressure	Power 0,125 – 10 kW	> 10 kW – 500 kW
Axial	A	Static	2,74 * ln(Pe) – 6,33 + N	0,78 * ln(Pe) – 1,88 + N
	D	Total		
Centrifugal forward curved	A	Static		
	B	Total		
Centrifugal backward curved open wheel	A	Static	4,56 * ln(Pe) – 10,5 + N	1,1 * ln(Pe) – 2,6 + N
Centrifugal backward curved with housing & mixed flow	A	Static		
	B	total		
Cross flow fan	B	Total	1,14 * ln(Pe) – 2,6 + N	Not applicable
Box fan	D	Total	4,56 * ln(Pe) – 10,5 + N	1,1 * ln(Pe) – 2,6 + N
Roof fan (axial within)	A&C	Static	2,74 * ln(Pe) – 6,33 + N	0,78 * ln(Pe) – 1,88 + N
Roof fan (centrifugal within)	A&C	Static	4,56 * ln(Pe) – 10,5 + N	1,1 * ln(Pe) – 2,6 + N

These formulas are applied in this Impact Assessment for the calculation of base case energy efficiency.

Fan Efficiency in part load conditions

The Figure B.5 below shows the power input of a fan by fan volume for several part load control mechanisms (discharge dampers, inlet vanes, variable speed motor, controlled/variable pitch blades, cycling and the theoretical minimum).

Figure B.5a: Options for part load operation and the effect on power input

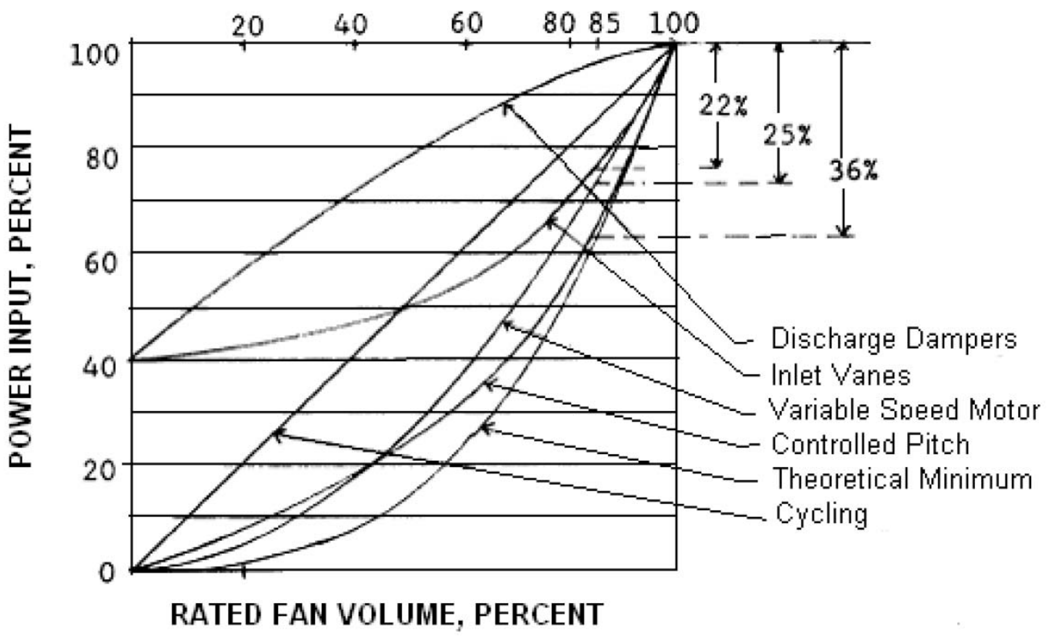
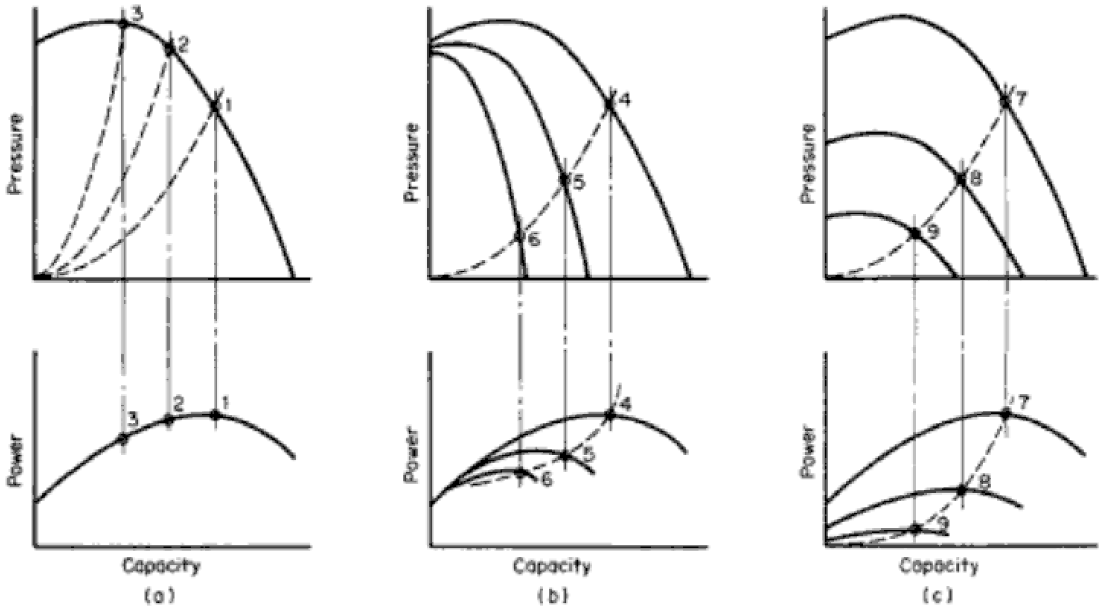


Figure B.5b: Fan (centrifugal back-ward) characteristics with (a) damper control (adds resistance), (b) variable-inlet vane control (reduces pressure producing capability), (c) variable speed control (reduces rpm)



Improvement potential

As described more in detail in the preparatory study, the applied research is focused on the efficiency improvement of the fan impeller/blade design to reduce the aerodynamic losses. The aerodynamic losses can be significantly reduced by aerofoil bladed design (curved and twisted profiles instead of flat sheet metal blades) and additional features such as winglet as the end of the profile to reduce tip losses. Aerofoil blade designs are today designed using CFD software; however production of such complex geometries is much more expensive. The state of the art at the product level can therefore be expressed as maximum efficiencies of a product already on the market providing easy access to efficient technologies without the need of fundamental R&D activities.

At a component level, the development of better aerodynamic blade profiles is underway. If the aerodynamic losses can be reduced, the efficiency of the products can be significantly increased compared to simple not profiled blades. However it is less a question of what can be done but more a question of what will be paid by the customer. Continuous work is underway which is also reflected by the large variety of efficiencies for the same product category and size (see preparatory study, e.g. chapter chapters 6 and 7). The aim of manufacturers tends actually therefore more to profiles which are cheaper to manufacture instead of improving the efficiency to a maximum. Also new design options such as winglets at the tip of the blades are tested. However, there is no special BAT design feature but a number of alternatives that all can do. Similar trends can be also identified for centrifugal fans. Profiled impellers made from composite material with optimised rotating diffuser by using new design principles to increase efficiency. Often insides from the aerospace sector are used to improve the design. Computer modelling can be used to tweak the blade including rounding off the blade's leading edge.

As to the market trends and best non-available technology, the preparatory study shows that trends in materials have been characterized for many years as a 'mature' product. Thus about

50 years ago centrifugal impeller hubs were sand castings riveted to steel back plates with blades riveted to the back plates and shrouds. The early axial fans again had cast iron hubs with single plate steel blades riveted on. Casings in all cases were either manufactured in riveted steel or, for a significant number, cast in iron. This was followed by welding which quickly became popular so that riveting for casing construction rapidly became obsolete, whilst cast iron casings were being replaced by welded steel fabrications. Impellers also became welded constructions. Overall, fans were subjected to a paint finish, which could be quite complex in its specification and was labour intensive. There was a demand for a more robust finish and competitive pressure dictated that this should be cheaper. Galvanising, a term used for the coating of iron and steel components with zinc, was seen by many as an ideal solution. Initially the galvanising was carried out after manufacture by dipping in a bath of molten zinc. This continues to be a widely used method for axial flow fan casings, which incorporate a longitudinal welded joint, to this day.

For centrifugal fans, distortion of the large flat areas of casing during the galvanising process, had led to the belief that pre-galvanised sheet was the answer for many of the lighter duty fans used for applications such as air conditioning and general ventilation. This necessitated a joining method other than welding which would have destroyed the zinc at this junction between the side plates and the scroll. Pittsburgh lock forming and other similar methods were introduced at this time and have been widely used.

Many of the materials used in the aircraft industry have been 'handed-down' to the fan industry and this has certainly applied to the aluminium alloys. These materials became available in the late 1940s and have been widely used for axial flow fan impeller blades and hubs. Their high strength and low density are the desirable attributes for an impeller material. Stresses due to centrifugal force effects can then be minimised and this has led to axial flow fans securing an ever-increasing share of the fan market. In the larger fan duties it has almost replaced the forward curved bladed centrifugal fan, which has been restricted to the smaller sizes.

The casting process (sand, gravity die or pressure die) for aerofoil section blades is still an expensive process and has led to the introduction of engineering grades of plastic. The use of these for impeller parts has increased enormously over the last two decades especially in small fans of all types. There has also been an increase in their use for the blades of axial flow fans of the very largest sizes

Thermoplastic polymers can be re-softened by heating, in contradistinction to thermo sets, which cannot. Many practical applications of plastics for fans however required the use of composites to achieve the necessary strength and durability. Thermoplastic materials for fans are the most wide used at the moment, and their use is expected to become ever more popular in the future.

The group of materials with the most exciting future is seen to be the composites. Until now the most common strengthening agent has been glass fibre. Again mirroring the aircraft industry, we may envisage the increasing use of carbon fibre reinforced plastics.

ANNEX C: LCC calculation explained

Life Cycle Cost (LCC) calculation is used to define the point where the increase of efficiency exceeds economic optimum. This optimum is defined as the Least Life Cycle Cost (LLCC) point.

The preparatory study provided the input values used for the assessment, such as list prices and efficiencies. All data is based on fans of base case power (average fan size). The base case purchase price is not identical to the average list price, but in many cases lower than the list price due to discounts given to trade partners. Only for centrifugal fans the base case prices are higher than the list 'average' list price for that power value. The difference is expressed as an correction factor which is used to calculate the lower and higher base case prices (list price * correction factor).

Table C.1: Purchase costs by fan type (based on min-max list prices and base case purchase price)

List price Purchase costs [EUR]				base case purchase price	correction
Fan type	lowest eff.	average eff.	highest eff.		
Axial<300Pa	800	909	1500	450	0,50
Axial>300Pa	1000	1231	1500	600	0,49
Centr.FC	500	697	1100	750	1,08
Centr. free/plug	750	1184	1750	1.400	1,18
Centr.BC	1250	2162	3750	3.000	1,39
Cross-flow	500	695	1100	600	0,86
Box	500	917	1500	800	0,87
Roof axial	750	1151	2250	1050	0.91
Roof centr.	1000	1534	3000	1.400	0,91

Using the correction factor identified above the range of purchase costs is defined (from lowest to highest). These prices are assumed to apply to fans of corresponding lowest and highest efficiencies.

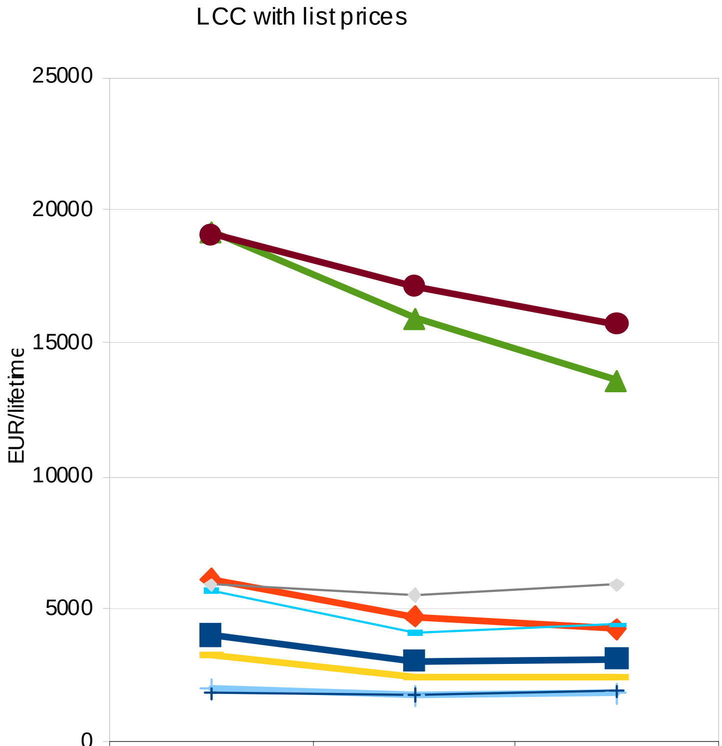
Table C.2: Fan type efficiency and purchase costs

Fan category	base case power	Efficiency (static)			Purchase costs [EUR]			Running hours	Product life	Electricity price
	[kW]	lowest eff.	average eff.	highest eff.	lowest eff.	average eff.	highest eff.		[year]	EUR
Axial<300Pa	0,8	20%	31%	40%	396	450	743	2000	15	0.087
Axial>300Pa	1,32	25%	37%	47%	487	600	731	2000	15	0.087
Centr.FC	0,44	20%	32%	42%	538	750	1184	3000	15	0.087
Centr. free/plug	3,76	45%	56%	70%	887	1400	2069	3000	15	0.087
Centr.BC	3,82	45%	54%	67%	1734	3000	5203	3000	15	0.087
Cross-flow	0,42	5%	7%	10%	432	600	950	1865	15	0.087
Box	0,37	15%	23%	45%	436	800	1308	1715	15	0.087
Roof axial	0.9	15%	25%	35%	684	1050	2053	2520	15	0.087
Roof centr.	1,2	35%	44%	60%	913	1400	2737	2520	15	0.087

For each of the lowest-average-highest combination of efficiency+purchase price the life cycle costs are calculated (based on base case running hours and power). In the main text calculated LCC-values are presented.

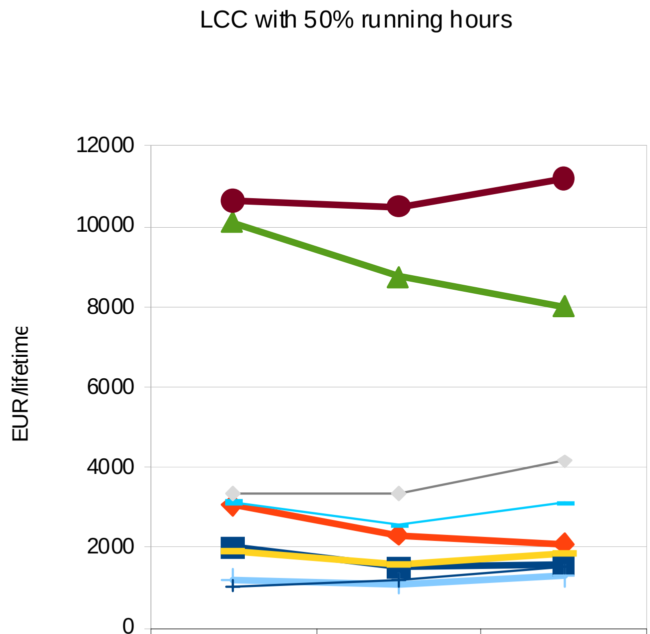
In order to assess the sensitivity of the LCC calculations for various parameters the following pages present the life cycle costs for:
List prices (instead of purchase prices – list prices are higher than purchase prices);
Running hours reduced (50%of original hours);
Increased List price increased (150% of original prices).

Figure C.1: LCC values with list price (higher than purchase price)



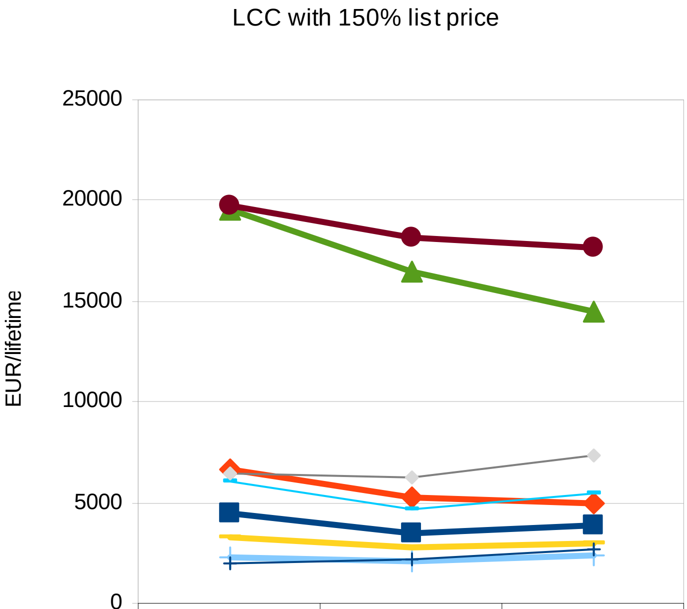
	lowest eff.	average eff.	highest eff.
Axial<300Pa	4022	2997	3111
Axial>300Pa	6109	4676	4217
Centr.FC	3262	2420	2415
Centr.BC-free	19195	15904	13608
Centr.BC	19100	17118	15739
Cross-flow	1988	1717	1844
Box	1777	1745	1926
Roof_axial	5683	4110	4364
Roof_centr.	5912	5480	5865

Figure C.2: LCC values for 50% of running hours



	lowest eff.	average eff.	highest eff.
Axial<300Pa	2007	1494	1548
Axial>300Pa	3042	2323	2090
Centr.FC	1919	1611	1841
Centr.BC-free	10109	8760	7998
Centr.BC	10660	10478	11197
Cross-flow	1176	1111	1322
Box	1075	1214	1521
Roof_axial	3151	2530	3110
Roof_centr.	3369	3373	4171

Figure C.3: LCC values for 150% of list price



	lowest eff.	average eff.	highest eff.
Axial<300Pa	4422	3451	3861
Axial>300Pa	6609	5292	4967
Centr.FC	3262	2768	2965
Centr.BC-free	19570	16497	14483
Centr.BC	19725	18199	17614
Cross-flow	2238	2064	2394
Box	2027	2204	2676
Roof_axial	6058	4686	5489
Roof_centr.	6412	6247	7365

ANNEX D: Scenario Inputs

Sales

The below table shows the estimated sales of fans used in buildings[31]

Table D.1: Breakdown of fan sales (EU27 in 2005)

buildings	subtype			type total	
	[mio]	[mio]	[mio]	[mio]	[%]
	Axial Highpressure	Axial Lowpressure			
res.	0.7	1.7	-	2.4	47%
non-res.	2	0.7	-	2.7	53%
				5.1	
	FC	free	BC		
res.	0.02	0	0.002	0	0%
non-res.	1.1	0.3	0.4	1.8	100%
				1.8	
	CrossFl	box	roof		
res.	0.06	0.8	0.7	1.6	27%
non-res.	0.2	1.5	2.7	4.4	73%
				6.0	
Total				12.9	

The results of the stakeholder consultation showed a preference in including all fans covered by the technical definitions used in the preparatory study. This would ensure level playing field for the industry, as it is beyond the market forces to control to which sector a given fan is been sold.

During the impact assessment stakeholders have been asked to give their view of the EU fan market in question. Few stakeholders were able to respond, since comprehensive fan sales data is very scattered and hard to produce. Confidentiality of sources was agreed in order to receive this data. The table below shows the overlaps between the motor and the fan measures.

[31] The preparatory study considered fans for buildings in non-residential sector. As fan sales can not be controlled based on given sector and as there is no difference in fan types used in industrial or residential sector, all fans covered by the technical definitions used in the preparatory study are included in this impact assessment.

Table D.2: Overlaps between the fan and the motor measure considered in the impact assessment

Fan power range	Share of total electricity consumption	Expected motor efficiency	First motor requirements	Second motor requirements	Third motor requirements
		before June 2011	June 2011-jan 2015	Jan 2015 - Jan 2017	after Jan 2017
0,125 - 0,75 kW	About 20% of energy consumption	IE1			
0,75 - 375 kW	About 80% of energy consumption	IE1	IE2	IE3 or IE2 + VSD (only for motors above 7,5 kW)	IE3 or IE2 + VSD
375 kW- 500 kW	not quantified as no models found (no data available)	IE1	IE2	IE3 or IE2 + VSD	IE3 or IE2 + VSD

The efficiency of the driven fan is determined by the impeller efficiency, tranmission efficiency, motor efficiency, a matching factor and a factor compensating extra losses from VSD's. The efficiency calculation of a driven fan is shown in the below table.

Table D.3: efficiency calculation of fans considered

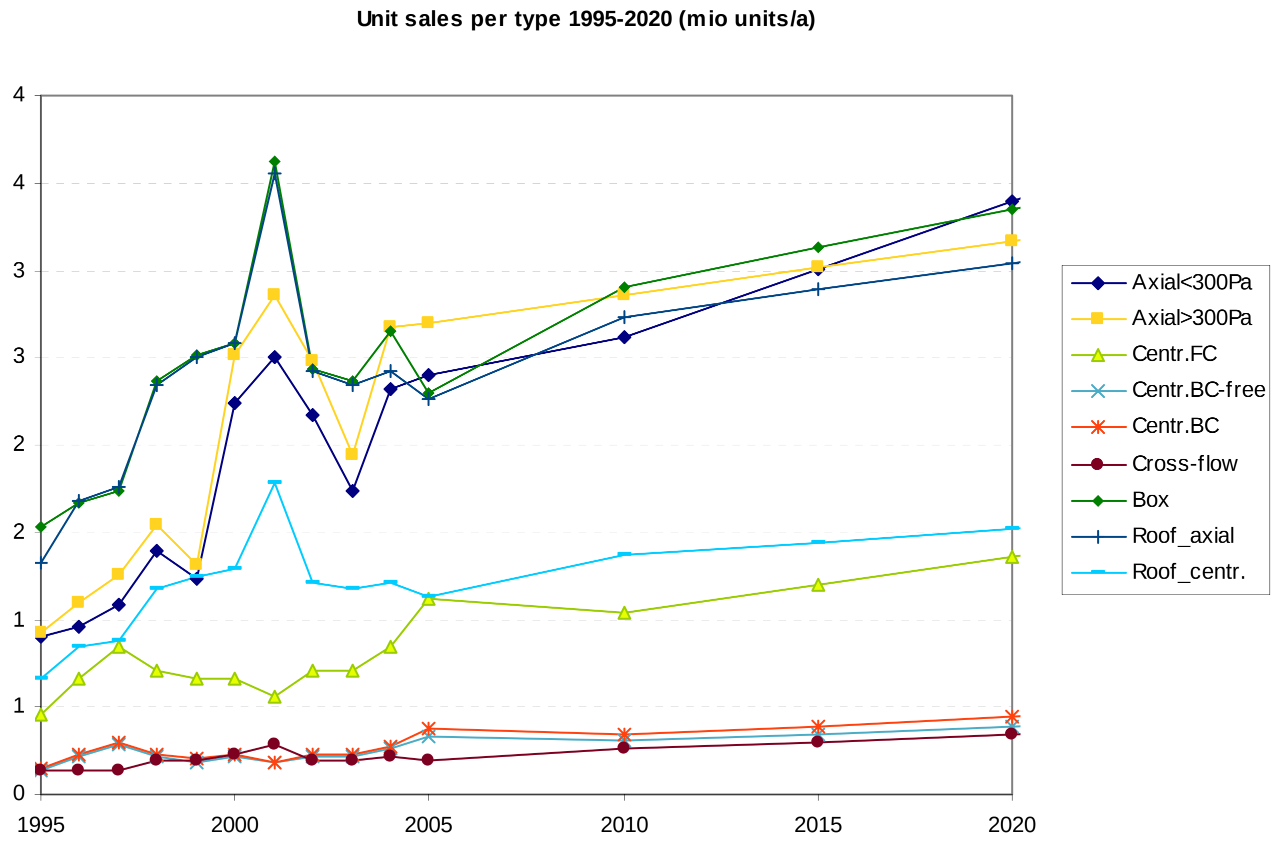
					driven fan efficiency
fans with integrated motor (incl. fan products)	fan efficiency ne (overall efficiency)	no VSD losses		Cd = 100%	na*Cd
		with VSD losses	Pe <= 1 kW	Cd = 1.15	
			1 kW < Pe < 5 kW	Cd = 1.11	
			Pe >= 5 kW	Cd = 1.04	
fans without motor (bare shaft)	fan wheel efficiency na (shaft power)	motor losses	Pe < 1 kW	Cm=0.0629*ln(Pw)+0.6538, Pw = shaft power	na*Cm*Ct*Cc
			Pe > 1 kW	Cm = assume IE1	
		transmission losses	no transmission (direct drive , coupling)	Ct = 100% efficiency	
			Pe < 1 kW	Ct = 87% efficiency	
			1 kW < Pe < 5 kW	Ct = 90% efficiency	
			Pe > 5 kW	Ct = 96% efficiency	
		component matching losses	all sizes	Cc = 90% efficiency	

The break up of the sales according to the fan type is given below. The fan unit sales of 2010 and beyond have been established on the basis of historic sales (multi-year average).

Table D.4: Unit sales (million) by fan type

Fan type	sales [mio units]						
	1995	2000	2005	2010	2015	2020	2025
Axial<300Pa	0,90	2,25	2,40	2,62	3,00	3,39	3,78
Axial>300Pa	0,93	2,51	2,70	2,86	3,01	3,17	3,33
Centr.FC	0,46	0,66	1,12	1,04	1,20	1,36	1,52
Centr.BC-free	0,14	0,21	0,33	0,31	0,35	0,39	0,43
Centr.BC	0,14	0,23	0,37	0,34	0,39	0,44	0,49
Cross-flow	0,13	0,23	0,19	0,26	0,30	0,34	0,37
Box	1,53	2,58	2,30	2,91	3,13	3,35	3,57
Roof axial	1.33	2.58	2.42	2,74	2,89	3,04	3,19
Roof_centr.	0.66	1.29	1.21	1,37	1,44	1,52	1,59
TOTAL	6,23	12,54	12,81	14,44	15,72	16,99	18,27
			100%	113%	123%	133%	143%

Figure D.1: Unit sales (million) by fan type



The table above shows the dominance of axial fans (around 40% of sales), roof fans (almost 30% of sales), and box fans (almost 20% of sales). The cross-flow fan did not meet the

Ecodesign criteria of 200.000 units/year in 2005, but is expected (if the sales trend of the last 10 years persists) to be above this threshold before 2010.

Product life

The product life is estimated to be 15 years for all fan categories (source: preparatory study). This corresponds to a total of 34000 running hours in the fan lifetime if the average fan (all categories, sales weighted) runs 2307 hours/a.

Stock / installed base

On the basis of a product life of 15 years (all categories) the EU27 stock is calculated up to 2020. The stock is not calculated per category, but for all together. An indication of a probable split-up per fan category is provided below (based on a simpler analysis of sales, not based on product life).

Table D.5: Approximation of stock by fan type

Fan category	sub-category	stock 2005	stock 2020
Axial	static pressure difference ≤ 300 Pa	17%	19%
	static pressure difference > 300 Pa	18%	19%
Centrifugal	forward curved blades (in scroll shaped housing)	7%	8%
	plug/plenum fan (no scroll housing)	2%	2%
	backward curved or aerofoil blades (in scroll housing)	2%	2%
Cross-flow	(no subset)	2%	2%
Box fan		21%	20%
Roof axial		20%	21%
Roof centr.		10%	9%
TOTAL		47 mio	90 mio

Fan base cases (inputs)

For each fan category the preparatory study provided inputs that describe the average (base case) fan per category.

Table D.6: Definition of Base cases (source: preparatory study)

Type of fan	Base case size	operating hours	electricity consumption	average efficiency driven fan (static pr.)	average purchase price	electricity consumption if efficiency =100%	installation costs	lifetime maintenance costs	annual maintenance costs
	[kW]	[hr/a]	[kWh/a]	[%]	[EUR]		[EUR]	[EUR]	[EUR/a]
Axial	1,08	2.000	2.151	34%	529	751	50	106	7
Centr.FC	0,44	3.000	1.320	32,1%	750	423	50	150	10
Centr. free/plug	3,76	3.000	11.280	56,4%	1.400	6.360	140	280	19
Centr.BC	3,82	3.000	11.460	53,7%	3.000	6.155	300	500	33
Cross-flow	0,42	1.865	783	7,3%	600	57	50	120	8
Box	0,37	1.715	635	23,1%	800	147	80	160	11
Roof axial	0,9	2.520	2.268	25%	1050	567	140	210	14
Roof centr.	1,2	2.520	3.024	43,6%	1.400	1.317	140	280	19

The electricity consumption at 100% efficiency is the 'work' performed by the fan, which is calculated by multiplying the final electricity consumption by the efficiency. The aim is to provide a basis for calculating what happens if efficiency increases (with constant load and increasing efficiency final electricity consumption goes down). The load is corrected for changes in the sales of fan categories in the stock model.

Technical / Economic variables

The calculation of changes in electricity consumption and related environmental impacts (primary energy use and CO_2 emissions), expenditure (purchase price, running costs), sector turnover and related jobs and other impacts due to increase of efficiency are calculated using basic technical/ economical variables that are shared by all scenario's.

The table below lists these variables.

Table D.7: Economic variables and other inputs for scenario calculations

Variables			Notes
Base price	862	Average purchase price incl. VAT in year 2005 [€]	
PriceInc Eur	28,15	Price increase per efficiency %-point [€/ %]	See below
PriceDec	0,1%	Annual product price decrease [%/ a]	Estimated value
Rmaint	7	Annual maintenance costs [€/ a]	Preparatory study
Rmaintinc	0%	Annual cost increase maintenance [%/ a]	Estimated value
Install	52	Install costs [€/]	Preparatory study
InstallDec	0,0%	Annual installation cost decrease [%/ a]	Estimated value
Rel	0,087	Electricity rate industry 2005 [€/ kWh electric]	Aligned with other Lot 11 studies
Rgas	0,047	Gas rate 2005 [€/ kWh primary GCV]	Not used
Roil	0,061	Oil rate 2005 [€/ kWh primary GCV]	Not used
CO2el	0,458	CO2 emission electricity, EU27 average [Mt CO2/TWh]	Default
Relinc	4%	Annual price increase electricity [%/ a] (inflation rate)	Default
Rgasinc	5,60%	Annual price increase gas [%/ a]	Not used
Roilinc	8,20%	Annual price increase oil [%/ a]	Not used
ManuFrac	50,0%	Manufacturer Selling Price as fraction of Baseprice [%]	Estimated value
WholeMargin	30%	Margin Wholesaler [% on msp]	Estimated value
RetailMargin	20%	Margin Retailer on product [% on wholesale price]	Estimated value
VAT	19%	Value Added Tax [in % on retail price]	Default
ManuWages	0,187	Manufacturer turnover per employee [mln €/ a]	based on annual reports manufacturers
OEMfactor	0,3	OEM personell as fraction of manufacturer personell [-]	Estimated value
WholeWages	0,261	Wholeseller turnover per employee [mln €/ a]	Estimated value
RetailWages	0,1	Retailer/installer turnover per employee [mln €/ a]	Estimated value
ExtraEUfrac	0,2	Fraction of OEM personell outside EU [fraction of OEM jobs]	Estimated value
Discount	4%	Discount rate [%/a] according IA Guidelines	Default
ProductLife	15	Product Life [years]	Preparatory study

The **price increase per efficiency** point is calculated on the basis of the base case purchase price and efficiency and is corrected for sales per fan category. The unit gives an indication of how much the purchase price increases if the fan becomes 1% more efficient.

Table D.8: Average purchase price increase per percentage point improvement of fan efficiency

	Purchase price [EUR]	Average Efficiency [%]	Sales (2005)	price increase per efficiency point [EUR/%]
Axial	529	34%	30%	16
Centr.FC	750	32%	12%	23
Centr.BC-free	1.400	56%	4%	25
Centr.BC	3.000	54%	4%	56
Cross-flow	600	7%	2%	82
Box	800	23%	17%	35
Roof axial	1050	25%	20%	42
Roof_centr.	1.400	44%	10%	32
AVERAGE (sales weighted)				28

Normally one would consider that the manufacturing industry, through rationalisation of the production process and labour shifts to low-wages countries, would realize a **price decrease** of around 2% annually. However, in this particular case with a product price very much influenced by the volatile copper and steel prices, it is expected that the cost reduction through rationalization will be barely enough to compensate for higher material prices.

The **turnover per employee** for the manufacturing industry is based upon values form manufacturers annual reports (dated 2007/2008).

Table D.9: Turnover per employee for several fan manufacturing sites

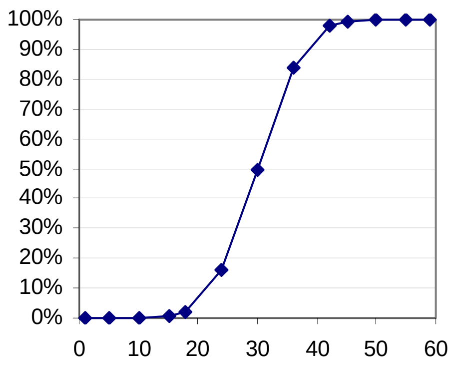
Company	Turnover [mio]	Employees [*1000]	turnover/employee [mio/employee]
EBMPapst overall	1076	9898	0.109
Location: Mulfingen	460	2538	0.181
Location: StGeorgen	264	1630	0.162
Location: Landshut	195	1014	0.192
FlaktWoods overall	630	3200	0.197
ZiehlAbegg	303	1500	0.202
simple average			0.187

Calculation of average sales efficiency in the sub-options

The preparatory study did not identify the average efficiencies per fan category after implementation of the ecodesign requirements. Furthermore, since a staged approach is applied the average fan efficiency of the 2nd stage is influenced by the introduction of the 1st stage, a method for calculating the new efficiency of the fan population after implementation of minimum efficiency requirements was applied. The principle is explained below.

Assumed is that a correlation exists between the range in efficiency of a fan category (min/max %) and the population (always 100%). For 'normal distributed' populations this correlation is a curve as presented below, the position and shape of it determined by the 'mean' (average efficiency) and 'standard deviation' (average across all fan types is **6%**). This means that 68% of the population is within 24%-36% efficiency and 95% of the population is within 18%-42% efficiency.

Figure D.2: Normal distribution (cumulative) with horizontal axis showing the average '30' (= 30% efficiency) and standard deviation '6' (sd=6%). The vertical axis is the related % population.



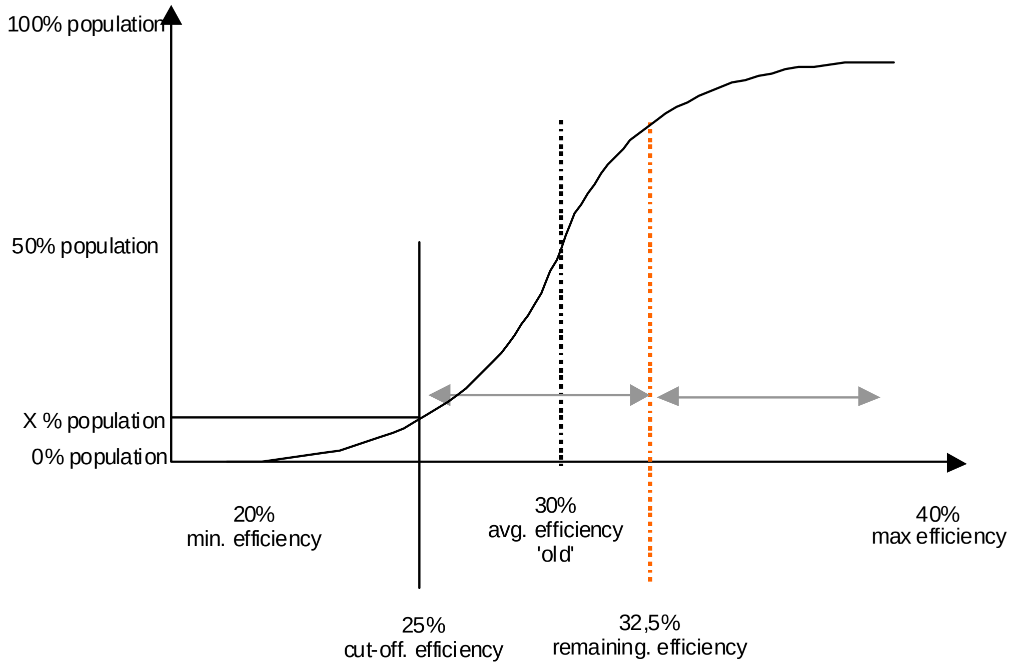
With the correlation between efficiency and % of population known any cut-off value (minimum efficiency requirement) can be recalculated to represent a certain share of the population of fans (in the example below this is called X%).

Table D.10: Standard deviation by fan type

Fan type	standard deviation
Axial	5,3%
Centr.FC	5,5%
Centr.BC-free	6,3%
Centr.BC	5,5%
Cross-flow	1,3%
Box	7,5%
Roof axial	5,0%
Roof centr.	6,3%
overall	5,9%

If it is assumed that the population of fans that is cut-off is replaced by fans with the 'old' average efficiency (here 30%), and the remaining population has a 'remaining' efficiency calculated to be right between the maximum efficiency (here 40%) and the cut-off value, this remaining population efficiency is probably close to (40%-25%)/2 + 25% = 32,5%. The combined overall 'new' average efficiency can be calculated using the shares of the cut-off and remaining population: (X% * 'old') + (100%-X%)*'remaining' = 'new' efficiency.

Figure D.3: Approach to calculate efficiency of population after minimum efficiency requirement



This approach is repeated for a second and third stage requirement using the previous stage 'new' efficiency as input 'average' efficiency of the following stage.

Using the method described above and the sales values presented elsewhere in this report the 'new' efficiency values for the average new fan were calculated, for each sub-option and fan category. The stock model uses as input the sales weighted overall-average (bottom line per table, in bold).

The table below gives the cut-off percentages per FMEG level applied[32].

32 The calculation of % cut-off is based upon 2005 average efficiency levels at base case electric input power and assuming normally distributed populations. The standard deviation varies per fan type. See also Annex D.

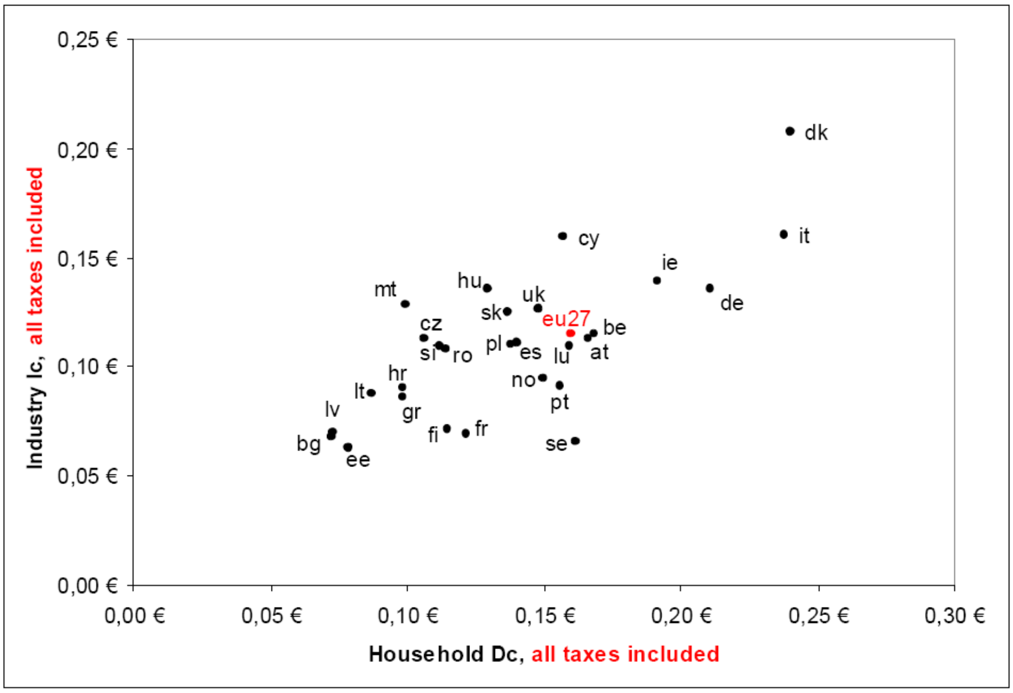
Table D.11: Overview FMEG values per scenario and corresponding cut-off percentages (population 2005)

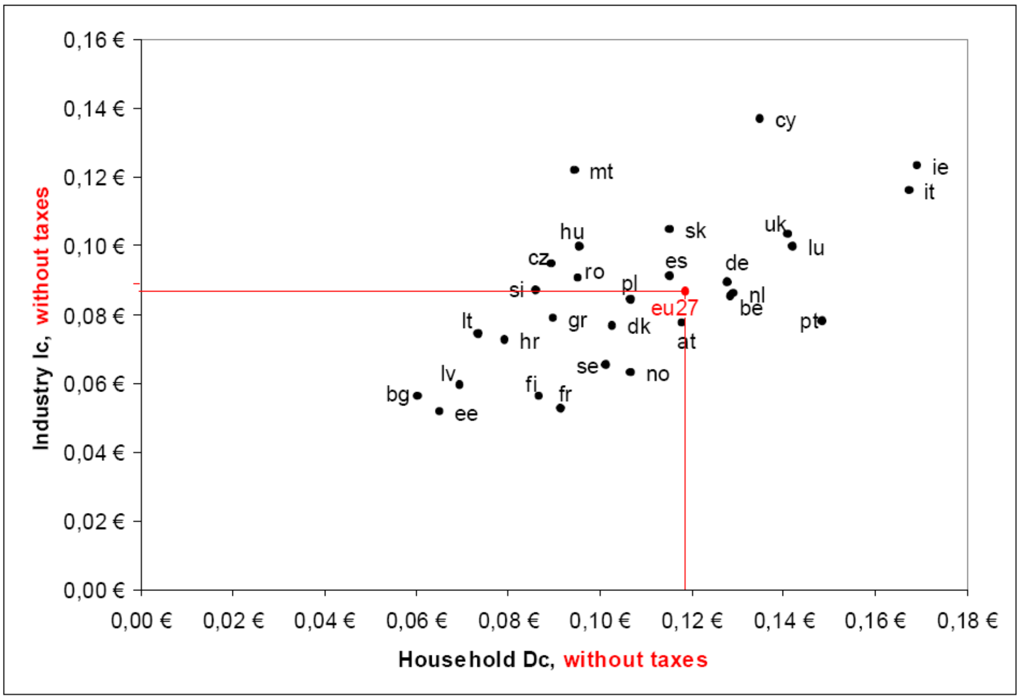
Scenario		1		2		3		4	
Year implementation		2012	2020	2011	2015	2012	2015	2012	2015
Fan minimum efficiency at base case power (FMEG grades)									
Axial		36	40	34	35	35	38	36	40
Centr.FC		35	39	37	39	39	42	37	42
Centr.BC-free		58	62	55	57	59	61	58	62
Centr.BC		55	60	58	59	59	61	58	61
Cross-flow		11	13	12	14	16	20	12	14
Box		35	39	35	39	35	39	35	39
Roof_axial		27	31	27	31	27	31	27	31
Roof_centr.		48	52	48	52	48	52	48	52
% cut-off fan population 2005									
Axial		14%	38%	11%	15%	15%	31%	14%	38%
Centr.FC		15%	38%	25%	38%	38%	60%	25%	60%
Centr.BC-free		32%	57%	17%	27%	38%	51%	32%	57%
Centr.BC		29%	64%	49%	57%	57%	70%	49%	70%
Cross-flow		54%	96%	82%	99%	100%	100%	82%	99%
Box		34%	54%	34%	54%	34%	54%	34%	54%
Roof_axial		22%	51%	22%	51%	22%	51%	22%	51%
Roof centr.		20%	42%	20%	42%	20%	42%	20%	42%

EU27 Electricity rates

Figure D.4: EU27 Electricity rates 2007

Source : Eurostat Oct. 2008 relating to retail prices 2nd semester 2007. Range for annual consumption of Household band Dc : [2 500 kWh – 5 000 kWh] ; Industry band Ic : [500 MWh – 2 000 MWh]





The electricity rate for industry, excluding taxes, is: € 0,087

ANNEX E: BaU and sub-options

BAU

The business-as-usual (BAU) assumes no improvement in average fan efficiency (no market factors driving average efficiency upward). The overall average fan efficiency however does change due to a changing ratio of fan sales by type.

The BAU shares its input values as regards sales and stock of fans, electricity prices and discount rates, product life and many more economic variables with the sub-options considered. The impacts of the sub-options are compared with BAU, which provides the reference.

Sub-option A

Sub-option A assumes FMEG [33] efficiency values for 2012 and 2015 based upon the original CSWD levels (presented below as efficiency at base case level) backed by the preparatory study.

Table E.1: Scenario A efficiency values

			Stage 1		Stage 2	
Fan type	Base case power	Avg. efficiency	CSWD Base case efficiency	Corresponds to FMEG value	CSWD Base case efficiency	Corresponds to FMEG value
Axial	1,08	34,2%	28,5	36	32.5	40
Centr.FC	0,44	32,1%	26,4	35	30,4	39
Centr. BC freewheel	3,76	56,4%	53,4	58	57,4	62
Centr. BC with scroll housing	3,82	53,7%	50,6	55	55,6	60
Cross-flow	0,42	7,3%	7,8	11	9,8	13
Box fans	0,37	23,1%	20,0	35	24,0	39
Roof - axial	0,9	25%	19,6	27	23,6	31
Roof - centrifugal	1,2	43,6%	38,1	48	42,1	52

Differences compared to the original CSWD proposal are:

Cross flow fans are not phased out (they represent only 0,5% of total energy consumption by fans considered)

The first stage (originally 2010) is omitted and the second stage (originally 2011) is implemented by 2012. The third stage (originally 2020) has now become the second stage and is implemented in 2015. These implementation dates are considered more realistic by all stakeholders concerned.

[33] FMEG stands for Fan Motor Efficiency Grade

The original efficiency values were based upon different log-formulas. Stakeholders have expressed their wishes to conform to the forthcoming ISO 12759 which uses slightly different lines. This Impact Assessment is based upon these new efficiency lines, and therefore the FMEG values (always whole numbers) result in slightly different efficiency levels than originally proposes. The difference is however limited to max 0,5% efficiency point.

Sub-option B

This sub-option was proposes by the fan manufacturing industry following the presentations by the Consultation Forum. The responsible industry Committee is ISO/TC 117 who also are responsible for ISO 12759. One modification has been made to the original document: Instead of three implementation dates this sub-option considers only two implementation dates (2012 and 2015) since these are considered the most achievable). The original stage 1 is omitted.

This proposal presents slightly lower FMEG values than assessed for the CSWD sub-option. Only for Centrifugal Forward Curved, Centrifugal Backward curved with housing and Cross flow fans slightly more ambitious levels than in the CSWD sub-option are proposed for stage 1. This is taken into account in Sub-option 4 as well. For stage 2 only the more ambitious level for cross flow fans remains (the sub-option 1 level for cross flow fans achieves 9.8% efficiency, sub-option 2 achieves 10.4% efficiency - the difference is very small).

Table E.2: Sub-option 2 efficiency values

			Stage 1		Stage 2	
Fan type	Base case power	Avg. efficiency	Base case efficiency	Corresponds to FMEG value	Base case efficiency	Corresponds to FMEG value
Axial	1.08	34,2%	27,3	34	28.3	35
Centr.FC	0,44	32,1%	27,9	37	29,9	39
Centr. BC freewheel	3,76	56,4%	50,9	55	52,9	57
Centr. BC with scroll housing	3,82	53,7%	53,9	58	54,9	59
Cross-flow	0,42	7,3%	8,4	12	10,4	14
Box fans	0,37	23,1%	20,0	35	24,0	39
Roof - axial	0,9	25%	19,6	27	23,6	31
Roof - centrifugal	1,2	43,6%	38,1	48	42,1	52

Sub-option C

This sub-option was proposed by the environmental NGO's (represented by ECOS) after the Consultation Forum meeting. One modification has been made to the original document: Instead of three implementation dates this sub-option considers only two implementation dates (2012 and 2015) since these are considered the most achievable. The original stage 1 is omitted..

The efficiency levels appear to be based upon those from the industry but then raised a few percentage points. The actual increase of levels when compared to sub-option 2 however varies per fan type: Especially for Centrifugal Forward Curved fans and cross flow fans the efficiency levels are much higher than in sub-option 1. For cross flow fans the proposed efficiency levels appear unattainable (twice the average efficiency).

Table E.3: Sub-option 3 efficiency values

			Stage 1		Stage 2	
Fan type	Base case power	Avg. efficiency	Base case efficiency	Corresponds to FMEG value	Base case efficiency	Corresponds to FMEG value
Axial	1.08	34,2%	28,3	35	31.3	38
Centr.FC	0,44	32,1%	29,9	39	32,9	42
Centr. BC freewheel	3,76	56,4%	54,9	59	56,9	61
Centr. BC with scroll housing	3,82	53,7%	54,9	59	56,9	61
Cross-flow	0,42	7,3%	12,4	16	16,4	20
Box fans	0,37	23,1%	20,0	35	24,0	39
Roof - axial	0,9	25%	19,6	27	23,6	31
Roof - centrifugal	1,2	43.6%	38,1	48	42,1	52

Sub-option D

Sub-option D was developed in the light of the stakeholder consultations during the impact assessment and explores the effects of stage 1 levels of lowest possible levels proposed in the three other sub-options and with the most stringent levels from either the proposal by CSWD, industry or environmental NGO's for the second stage. In this way, the industry is confronted with the least severe requirements from the start and is given time to adapt to the changed market situation. The second stage aims for the highest possible savings expressed in any of the other three sub-options.

Table E.4: Scenario 4 efficiency values

			Stage 1		Stage 2	
Fan type	Base case power	Avg. efficiency	Base case efficiency	Corresponds to FMEG value	Base case efficiency	Corresponds to FMEG value
Axial	1.08	34,2%	28,4	36	32.4	40
Centr.FC	0,44	32,1%	28,4	37	33,4	42
Centr. BC freewheel	3,76	56,4%	53,5	58	57,5	62
Centr. BC with scroll housing	3,82	53,7%	52,6	58	56,6	61
Cross-flow	0,42	7,3%	8,4	12	10,4	14
Box fans	0,37	23,1%	20,0	35	24,0	39
Roof - axial	0,9	25%	19,6	27	23,6	31
Roof - centrifugal	1,2	43.6%	38,1	48	42,1	52

Comparison of the level of ambition between sub-options

The overview below presents the differences in ambition of all four sub-options when compared to the first sub-option. Red cells indicate lower ambitions than the CSWD, green cells indicate higher ambitions and yellow cells are equal ambitions. The value in the cell indicates the quantitative difference. Sub-option B (based on proposals by industry) shows the most red cells, especially in the second stage. Interestingly enough sub-option C, proposed by environmental NGO's also shows some red cells where the ambition is lower than in sub-option A. This is explained by the assumption that sub-option C is based upon sub-option B with raised efficiency levels. The conclusion is that, depending on fan type and implementation stage, either the first, second or third option presents the highest ambitions. This is reflected in sub-option D which does not contain red cells - this option is based upon presenting ambitions at least at the CSWD level, unless superseded by levels in sub-option B (the industry proposal) for the first stage, or by sub-option C (the environmental NGO proposal) for the second stage (the efficiency level for cross flow fans in sub-option C is considered unachievable).

Table E.5: comparison of sub-options per fan category

	1			2			3			4	
Axial	ref	ref		-2	-5		-1	-2		0	0
Centr.FC	ref	ref		2	0		4	3		2	3
Centr.BC-free	ref	ref		-3	-5		1	-1		0	0
Centr.BC	ref	ref		3	-1		4	1		3	1
Cross-flow	ref	ref		1	1		5	7		1	1
Box	ref	ref		0	0		0	0		0	0
Roof_axial	ref	ref		0	0		0	0		0	0
Roof_centr.	ref	ref		0	0		0	0		0	0

ANNEX F: Scenario Outputs (tables) and impacts on primary energy

Table F.1: STOCK Environmental									
	1990	**1995**	**2000**	**2005**	**2010**	**2013**	**2015**	**2020**	**2025**
net load (kWh/a)	**834**	**834**	**812**	**922**	**857**	**861**	**864**	**870**	**874**
sales (mio)	**5,54**	**6,23**	**12,54**	**12,81**	**14,44**	**15,20**	**15,72**	**16,99**	**18,27**
park (mio)	**54**	**73**	**105**	**143**	**183**	**201**	**208**	**227**	**247**
Efficiency									
Freeze_2005	**31%**	**31%**	**31%**	**32%**	**31%**	**31%**	**31%**	**31%**	**31%**
BaU	**31%**	**31%**	**31%**	**32%**	**31%**	**31%**	**31%**	**31%**	**31%**
1:_/12/15	**31%**	**31%**	**31%**	**32%**	**31%**	**35%**	**37%**	**37%**	**37%**
2:_/12/15	**31%**	**31%**	**31%**	**32%**	**31%**	**35%**	**36%**	**36%**	**36%**
3:_/12/15	**31%**	**31%**	**31%**	**32%**	**31%**	**35%**	**37%**	**37%**	**37%**
4:_/12/15	**31%**	**31%**	**31%**	**32%**	**31%**	**35%**	**37%**	**37%**	**37%**
kWh/a.unit									
Freeze_2005	**2717**	**2717**	**2610**	**2887**	**2732**	**2744**	**2752**	**2770**	**2785**
BaU	**2717**	**2717**	**2610**	**2887**	**2732**	**2744**	**2752**	**2770**	**2785**
1:_/12/15	**2717**	**2717**	**2610**	**2887**	**2732**	**2449**	**2355**	**2371**	**2385**
2:_/12/15	**2717**	**2717**	**2610**	**2887**	**2732**	**2468**	**2392**	**2408**	**2422**
3:_/12/15	**2717**	**2717**	**2610**	**2887**	**2732**	**2441**	**2350**	**2366**	**2379**
4:_/12/15	**2717**	**2717**	**2610**	**2887**	**2732**	**2445**	**2351**	**2367**	**2381**
TWh primary/a new sales (without corr.)									
Freeze_2005	**15**	**17**	**33**	**37**	**39**	**42**	**43**	**47**	**51**
BaU	**15**	**17**	**33**	**37**	**39**	**42**	**43**	**47**	**51**
1:_/12/15	**15**	**17**	**33**	**37**	**39**	**37**	**37**	**40**	**44**
2:_/12/15	**15**	**17**	**33**	**37**	**39**	**38**	**38**	**41**	**44**
3:_/12/15	**15**	**17**	**33**	**37**	**39**	**37**	**37**	**40**	**43**
4:_/12/15	**15**	**17**	**33**	**37**	**39**	**37**	**37**	**40**	**43**
Stock electricity in TWh/a									
Freeze_2005	**153**	**201**	**282**	**264**	**502**	**554**	**578**	**629**	**683**
BaU	**153**	**201**	**282**	**390**	**502**	**554**	**578**	**629**	**683**
1:_/12/15	**153**	**201**	**282**	**390**	**502**	**545**	**557**	**575**	**593**
2:_/12/15	**153**	**201**	**282**	**390**	**502**	**546**	**558**	**580**	**601**
3:_/12/15	**153**	**201**	**282**	**390**	**502**	**545**	**556**	**574**	**592**
4:_/12/15	**153**	**201**	**282**	**390**	**502**	**545**	**557**	**575**	**592**
Stock energy in PJ/a									
Freeze_2005	**551**	**724**	**1016**	**952**	**1805**	**1995**	**2079**	**2264**	**2459**
BaU	**551**	**724**	**1016**	**1404**	**1805**	**1995**	**2079**	**2264**	**2459**
1:_/12/15	**551**	**724**	**1016**	**1404**	**1808**	**1962**	**2005**	**2071**	**2136**
2:_/12/15	**551**	**724**	**1016**	**1404**	**1808**	**1964**	**2010**	**2088**	**2164**
3:_/12/15	**551**	**724**	**1016**	**1404**	**1808**	**1961**	**2003**	**2068**	**2131**
4:_/12/15	**551**	**724**	**1016**	**1404**	**1808**	**1962**	**2004**	**2069**	**2132**
CO2 in Mt (1 PJ= 0,0577 Mt)									
Freeze_2005	**70**	**92**	**129**	**121**	**230**	**254**	**265**	**288**	**313**
BaU	**70**	**92**	**129**	**179**	**230**	**254**	**265**	**288**	**313**
1:_/12/15	**70**	**92**	**129**	**179**	**230**	**250**	**255**	**263**	**272**
2:_/12/15	**70**	**92**	**129**	**179**	**230**	**250**	**256**	**266**	**275**
3:_/12/15	**70**	**92**	**129**	**179**	**230**	**250**	**255**	**263**	**271**
4:_/12/15	**70**	**92**	**129**	**179**	**230**	**250**	**255**	**263**	**271**

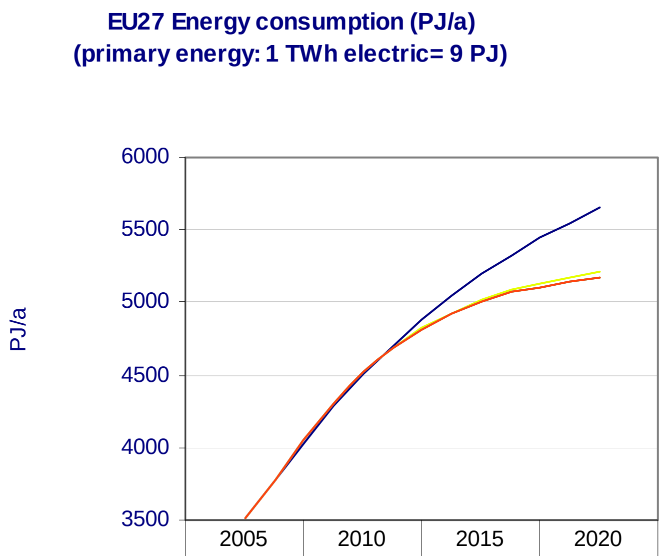
Table F.2: STOCK Customer Economics (not corrected for inflation unless indicated otherwise)									
	1990	**1995**	**2000**	**2005**	**2010**	**2013**	**2015**	**2020**	**2025**
Oil share	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**
Oil price	**0,019**	**0,028**	**0,041**	**0,061**	**0,090**	**0,115**	**0,134**	**0,199**	**0,295**
Gas price	**0,021**	**0,027**	**0,036**	**0,047**	**0,062**	**0,073**	**0,081**	**0,106**	**0,140**
El price	**0,048**	**0,059**	**0,072**	**0,087**	**0,106**	**0,119**	**0,129**	**0,157**	**0,191**
Maintenance	**4**	**5**	**6**	**7**	**9**	**10**	**11**	**13**	**16**
Share electricity									
Freeze_2005	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**
BaU	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**
1:_/12/15	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**
2:_/12/15	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**
3:_/12/15	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**
4:_/12/15	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**	**100,0%**
Avg. Fuel price									
Freeze_2005	**0,05**	**0,06**	**0,07**	**0,087**	**0,11**	**0,12**	**0,13**	**0,16**	**0,19**
BaU	**0,05**	**0,06**	**0,07**	**0,09**	**0,11**	**0,12**	**0,13**	**0,16**	**0,19**
1:_/12/15	**0,05**	**0,06**	**0,07**	**0,09**	**0,11**	**0,12**	**0,13**	**0,16**	**0,19**
2:_/12/15	**0,05**	**0,06**	**0,07**	**0,09**	**0,11**	**0,12**	**0,13**	**0,16**	**0,19**
3:_/12/15	**0,05**	**0,06**	**0,07**	**0,09**	**0,11**	**0,12**	**0,13**	**0,16**	**0,19**
4:_/12/15	**0,05**	**0,06**	**0,07**	**0,09**	**0,11**	**0,12**	**0,13**	**0,16**	**0,19**
Avg. Purchase Product (incl. install)									
Freeze_2005	**862**	**862**	**862**	**862**	**862**	**862**	**862**	**862**	**862**
BaU	**862**	**862**	**862**	**862**	**845**	**845**	**846**	**846**	**846**
1:_/12/15	**862**	**862**	**862**	**862**	**845**	**952**	**995**	**994**	**994**
2:_/12/15	**862**	**862**	**862**	**862**	**845**	**944**	**979**	**979**	**978**
3:_/12/15	**862**	**862**	**862**	**862**	**845**	**955**	**997**	**997**	**997**
4:_/12/15	**862**	**862**	**862**	**862**	**845**	**954**	**997**	**996**	**996**
Avg. Energy costs Eur/a.unit									
Freeze_2005	**131**	**160**	**187**	**251**	**289**	**327**	**354**	**434**	**531**
BaU	**131**	**160**	**187**	**251**	**289**	**327**	**354**	**434**	**531**
1:_/12/15	**131**	**160**	**187**	**251**	**289**	**292**	**303**	**372**	**455**
2:_/12/15	**131**	**160**	**187**	**251**	**289**	**294**	**308**	**377**	**462**
3:_/12/15	**131**	**160**	**187**	**251**	**289**	**291**	**303**	**371**	**453**
4:_/12/15	**131**	**160**	**187**	**251**	**289**	**291**	**303**	**371**	**454**
Total purchase costs EU per annum (inflation corrected, in Euro 2005)									
Freeze_2005	**2,8**	**3,8**	**9,4**	**11,7**	**10,8**	**10,0**	**9,5**	**8,4**	**7,4**
BaU	**2,8**	**3,8**	**9,4**	**11,7**	**10,6**	**9,8**	**9,4**	**8,3**	**7,3**
1:_/12/15	**2,8**	**3,8**	**9,4**	**11,7**	**10,6**	**11,0**	**10,9**	**9,6**	**8,4**
2:_/12/15	**2,8**	**3,8**	**9,4**	**11,7**	**10,6**	**10,9**	**10,8**	**9,5**	**8,3**
3:_/12/15	**2,8**	**3,8**	**9,4**	**11,7**	**10,6**	**11,0**	**11,0**	**9,7**	**8,5**
4:_/12/15	**2,8**	**3,8**	**9,4**	**11,7**	**10,6**	**11,0**	**11,0**	**9,7**	**8,5**
Total running costs (energy+maint) (inflation corrected, in Euro 2005)									
Freeze_2005	**7,4**	**11,8**	**20,2**	**23,0**	**53,1**	**66,0**	**74,4**	**98,5**	**130,2**
BaU	**7,4**	**11,8**	**20,2**	**33,9**	**53,1**	**66,0**	**74,4**	**98,5**	**130,2**
1:_/12/15	**7,4**	**11,8**	**20,2**	**33,9**	**53,2**	**64,9**	**71,7**	**90,1**	**113,1**
2:_/12/15	**7,4**	**11,8**	**20,2**	**33,9**	**53,2**	**65,0**	**71,9**	**90,9**	**114,6**
3:_/12/15	**7,4**	**11,8**	**20,2**	**33,9**	**53,2**	**64,9**	**71,7**	**90,0**	**112,8**
4:_/12/15	**7,4**	**11,8**	**20,2**	**33,9**	**53,2**	**64,9**	**71,7**	**90,0**	**112,9**
Customer expenditure (inflation corrected, in Euro 2005)									
Freeze_2005	**10,2**	**15,7**	**29,6**	**34,7**	**63,8**	**76,0**	**83,9**	**106,9**	**137,6**
BaU	**10,2**	**15,7**	**29,6**	**45,6**	**63,6**	**75,8**	**83,8**	**106,8**	**137,5**
1:_/12/15	**10,2**	**15,7**	**29,6**	**45,6**	**63,7**	**75,9**	**82,6**	**99,8**	**121,5**
2:_/12/15	**10,2**	**15,7**	**29,6**	**45,6**	**63,7**	**75,9**	**82,7**	**100,3**	**122,9**
3:_/12/15	**10,2**	**15,7**	**29,6**	**45,6**	**63,7**	**75,9**	**82,6**	**99,7**	**121,3**
4:_/12/15	**10,2**	**15,7**	**29,6**	**45,6**	**63,7**	**75,9**	**82,6**	**99,7**	**121,4**

Table F.3: STOCK Business Economics (inflation corrected, in Euro 2005)									
	1990	1995	2000	2005	2010	2013	2015	2020	2025
Avg. Product Price [Euro 2005]									
Freeze_2005	**875**	**870**	**866**	**862**	**841**	839	**837**	**833**	**830**
BaU	**875**	**870**	**866**	**862**	**841**	839	**837**	**833**	**830**
1:_/12/15	**875**	**870**	**866**	**862**	**841**	944	**985**	**980**	**975**
2:_/12/15	**875**	**870**	**866**	**862**	**841**	937	**969**	**964**	**959**
3:_/12/15	**875**	**870**	**866**	**862**	**841**	947	**987**	**982**	**977**
4:_/12/15	**875**	**870**	**866**	**862**	**841**	946	**987**	**982**	**977**
Avg. Energy/unit new sales [Euro 2005]									
Freeze_2005	**131**	**160**	**187**	**251**	**289**	327	**354**	**434**	**531**
BaU	**131**	**160**	**187**	**251**	**289**	327	**354**	**434**	**531**
1:_/12/15	**131**	**160**	**187**	**251**	**289**	292	**303**	**372**	**455**
2:_/12/15	**131**	**160**	**187**	**251**	**289**	294	**308**	**377**	**462**
3:_/12/15	**131**	**160**	**187**	**251**	**289**	291	**303**	**371**	**453**
4:_/12/15	**131**	**160**	**187**	**251**	**289**	291	**303**	**371**	**454**
INDUSTRY Turnover [€ bln 2005]									
Freeze_2005				**5,5**	**6,1**	6,4	**6,6**	**7,1**	**7,6**
BaU				**5,5**	**6,1**	6,4	**6,6**	**7,1**	**7,6**
1:_/12/15				**5,5**	**6,1**	7,2	**7,7**	**8,3**	**8,9**
2:_/12/15				**5,5**	**6,1**	7,1	**7,6**	**8,2**	**8,8**
3:_/12/15				**5,5**	**6,1**	7,2	**7,8**	**8,3**	**8,9**
4:_/12/15				**5,5**	**6,1**	7,2	**7,8**	**8,3**	**8,9**
WHOLESALER Turnover [€ bln 2005]									
Freeze_2005				**1,7**	**1,8**	1,9	**2,0**	**2,1**	**2,3**
BaU				**1,7**	**1,8**	1,9	**2,0**	**2,1**	**2,3**
1:_/12/15				**1,7**	**1,8**	2,2	**2,3**	**2,5**	**2,7**
2:_/12/15				**1,7**	**1,8**	2,1	**2,3**	**2,5**	**2,6**
3:_/12/15				**1,7**	**1,8**	2,2	**2,3**	**2,5**	**2,7**
4:_/12/15				**1,7**	**1,8**	2,2	**2,3**	**2,5**	**2,7**
INSTALLER Turnover [€ bln 2005]									
Freeze_2005				**0,0**	**0,0**	0,0	**0,0**	**0,0**	**0,0**
BaU				**0,0**	**0,0**	0,0	**0,0**	**0,0**	**0,0**
1:_/12/15				**0,0**	**0,0**	0,0	**0,0**	**0,0**	**0,0**
2:_/12/15				**0,0**	**0,0**	0,0	**0,0**	**0,0**	**0,0**
3:_/12/15				**0,0**	**0,0**	0,0	**0,0**	**0,0**	**0,0**
4:_/12/15				**0,0**	**0,0**	0,0	**0,0**	**0,0**	**0,0**
VAT on product (excl. Energy) Turnover [€ bln 2005]									
Freeze_2005				**1,4**	**1,5**	1,6	**1,6**	**1,8**	**1,9**
BaU				**1,4**	**1,5**	1,6	**1,6**	**1,8**	**1,9**
1:_/12/15				**1,4**	**1,5**	1,8	**1,9**	**2,1**	**2,2**
2:_/12/15				**1,4**	**1,5**	1,8	**1,9**	**2,0**	**2,2**
3:_/12/15				**1,4**	**1,5**	1,8	**1,9**	**2,1**	**2,2**
4:_/12/15				**1,4**	**1,5**	1,8	**1,9**	**2,1**	**2,2**
ENERGY SECTOR Turnover [€ bln 2005], incl. VAT and other taxes									
Freeze_2005				**23,0**	**53,1**	66,0	**74,4**	**98,5**	**130,2**
BaU				**33,9**	**53,1**	66,0	**74,4**	**98,5**	**130,2**
1:_/12/15				**33,9**	**53,2**	64,9	**71,7**	**90,1**	**113,1**
2:_/12/15				**33,9**	**53,2**	65,0	**71,9**	**90,9**	**114,6**
3:_/12/15				**33,9**	**53,2**	64,9	**71,7**	**90,0**	**112,8**
4:_/12/15				**33,9**	**53,2**	64,9	**71,7**	**90,0**	**112,9**
ALL SECTORS Turnover [€ bln 2005] (=consumer expenditure inflation corrected)									
Freeze_2005				**31,6**	**62,5**	75,9	**84,6**	**109,5**	**142,0**
BaU				**42,5**	**62,5**	75,9	**84,6**	**109,5**	**142,0**
1:_/12/15				**42,5**	**62,6**	76,0	**83,7**	**103,0**	**126,9**
2:_/12/15				**42,5**	**62,6**	76,0	**83,7**	**103,5**	**128,2**
3:_/12/15				**42,5**	**62,6**	76,0	**83,7**	**102,9**	**126,7**
4:_/12/15				**42,5**	**62,6**	76,0	**83,7**	**103,0**	**126,7**

Table F.4: STOCK Social-Economics									
	1990	**1995**	**2000**	**2005**	**2010**	2013	**2015**	**2020**	**2025**
INDUSTRY									
MANUFACTURER Personell [000]									
Freeze_2005				**29,5**	**32,5**	34,1	**35,2**	**37,9**	**40,5**
BaU				**29,5**	**32,5**	34,1	**35,2**	**37,9**	**40,5**
1:_/12/15				**29,5**	**32,5**	38,4	**41,4**	**44,5**	**47,6**
2:_/12/15				**29,5**	**32,5**	38,1	**40,7**	**43,8**	**46,9**
3:_/12/15				**29,5**	**32,5**	38,5	**41,5**	**44,6**	**47,7**
4:_/12/15				**29,5**	**32,5**	38,5	**41,5**	**44,6**	**47,7**
OEM Total Personell [000]									
Freeze_2005				**9**	**10**	10	**11**	**11**	**12**
BaU				**9**	**10**	10	**11**	**11**	**12**
1:_/12/15				**9**	**10**	12	**12**	**13**	**14**
2:_/12/15				**9**	**10**	11	**12**	**13**	**14**
3:_/12/15				**9**	**10**	12	**12**	**13**	**14**
4:_/12/15				**9**	**10**	12	**12**	**13**	**14**
of which OEM Personell in EU [000]									
Freeze_2005				**7**	**8**	8	**8**	**9**	**10**
BaU				**7**	**8**	8	**8**	**9**	**10**
1:_/12/15				**7**	**8**	9	**10**	**11**	**11**
2:_/12/15				**7**	**8**	9	**10**	**11**	**11**
3:_/12/15				**7**	**8**	9	**10**	**11**	**11**
4:_/12/15				**7**	**8**	9	**10**	**11**	**11**
WHOLESALER									
Personell Wholesaler [000]									
Freeze_2005				**6**	**7**	7	**8**	**8**	**9**
BaU				**6**	**7**	7	**8**	**8**	**9**
1:_/12/15				**6**	**7**	8	**9**	**10**	**10**
2:_/12/15				**6**	**7**	8	**9**	**9**	**10**
3:_/12/15				**6**	**7**	8	**9**	**10**	**10**
4:_/12/15				**6**	**7**	8	**9**	**10**	**10**
INSTALLER									
Personell [000]									
Freeze_2005				**0,12**	**0,13**	0,14	**0,14**	**0,15**	**0,16**
BaU				**0,12**	**0,13**	0,14	**0,14**	**0,15**	**0,16**
1:_/12/15				**0,12**	**0,13**	0,15	**0,16**	**0,18**	**0,19**
2:_/12/15				**0,12**	**0,13**	0,15	**0,16**	**0,17**	**0,18**
3:_/12/15				**0,12**	**0,13**	0,15	**0,16**	**0,18**	**0,19**
4:_/12/15				**0,12**	**0,13**	0,15	**0,16**	**0,18**	**0,19**
ALL SECTORS									
Personell x 1000									
Freeze_2005				**45**	**49**	52	**53**	**58**	**62**
BaU				**45**	**49**	52	**53**	**58**	**62**
1:_/12/15				**45**	**49**	58	**63**	**68**	**72**
2:_/12/15				**45**	**49**	58	**62**	**67**	**71**
3:_/12/15				**45**	**49**	58	**63**	**68**	**73**
4:_/12/15				**45**	**49**	58	**63**	**68**	**72**

Primary energy

Figure F.5: Primary energy scenarios.



	2005	2010	2015	2020
BaU	3509	4514	5198	5659
A: CSWD	3509	4521	5012	5178
B: Industry	3509	4521	5025	5219
C: EnvNGO	3509	4521	5007	5170
D: Compromise	3509	4521	5009	5172

Primary energy consumption follows the same trend as electricity consumption, with comparable savings.

Table F.6: Primary energy consumption and savings (PJ/a, %)

PJ	2005	2010	2015	2020	2025	savings 2020	
BaU	3509	4514	5198	5659	6147,5	ref	ref
A: CSWD	3509	4521	5012	5178	5339,5	-481,7	-8,5%
B: Industry	3509	4521	5025	5219	5410,2	-440,6	-7,8%
C: EnvNGO	3509	4521	5007	5170	5326,4	-489,8	-8,7%
D: Compromise	3509	4521	5009	5172	5330,0	-487,5	-8,6%

ANNEX G: Accumulative savings 2010-2020

The table below give an overview of accumulated impacts for the period 2010-2020.

Table G.1: Accumulative impacts 2010-2020

ACCUMULATIVE MAIN IMPACTS 2010-2020							
Totals (accumulated 2010-2020)			**Scenario's 2020**				
			1	**2**	**3**	**4**	**5**
IMPACTS (as Art. 15, sub. 4.e. of 2005/32/EC)			**BaU**	**1:_/12/15**	**2:_/12/15**	**3:_/12/15**	**4:_/12/15**
ENVIRONMENT							
	ENERGY	PJ/a	**56731**	**54480**	**54658**	**54435**	**54451**
	GHG	Mt CO2 eq./a	**2887**	**2772**	**2782**	**2770**	**2771**
	ELECTRICITY	TWh/a	**6303**	**6053**	**6073**	**6048**	**6050**
CONSUMER							
EU totals	expenditure	€ bln./a***	**928,1**	**905,2**	**906,9**	**904,8**	**904,9**
	purchase costs	€ bln./a	103,3	116,1	114,8	116,3	116,2
	running costs (electricity only)	€ bln./a	824,8	789,2	792,0	788,5	788,7
BUSINESS							
EU turnover	manuf	€ bln./a	**72,4**	**82,3**	**81,3**	**82,5**	**82,4**
	whole-sale	€ bln./a	**21,7**	**24,7**	**24,4**	**24,7**	**24,7**
	retail/installer	€ bln./a	**0,2**	**0,2**	**0,2**	**0,2**	**0,2**
Accumulated savings vs. Baseline			**Scenario's 2020**				
			1	**2**	**3**	**4**	**5**
IMPACTS (as Art. 15, sub. 4.e. of 2005/32/EC)			**BaU**	**1:_/12/15**	**2:_/12/15**	**3:_/12/15**	**4:_/12/15**
ENVIRONMENT							
	ENERGY	PJ/a	**ref**	**2251**	**2073**	**2296**	**2280**
	GHG	Mt CO2 eq./a	**ref**	**115**	**105**	**117**	**116**
	ELECTRICITY	TWh/a	**ref**	**250**	**230**	**255**	**253**
CONSUMER							
EU savings	expenditure	€ bln./a***	**ref**	**23**	**21**	**23**	**23**
	purchase costs	€ bln./a	**ref**	**-13**	**-12**	**-13**	**-13**
	running costs	€ bln./a	**ref**	**36**	**33**	**36**	**36**
	of which electricity	€ bln./a	**ref**	**0**	**0**	**0**	**0**
BUSINESS							
EU savings	manuf	€ bln./a	**ref**	**-10**	**-9**	**-10**	**-10**
	whole-sale	€ bln./a	**ref**	**-3**	**-3**	**-3**	**-3**
	retail	€ bln./a	**ref**	**0**	**0**	**0**	**0**
***=all money amounts in Euro 2005 (inflation corrected)							