Center of Energy and Processes | Van Holsteijn and Kemna | Building Research Establishment

Service Contract to DG Enterprise

Sustainable Industrial Policy –
Building on the Ecodesign Directive –
Energy-Using Product Group Analysis/2

Lot 6: Air-conditioning and ventilation systems

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Final Report Task 7

Policy- and scenario analysis

Prepared by VHK

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Separate Annex III:

Stakeholder Comments and Discussion

Note that the full list of Acronyms and symbols is incorporated in the Task 1 report

Introduction

This is the draft report for Task 7 on the Ventilation Systems, as part of the preparatory study on Air Conditioning and Ventilation Systems in the context of the Ecodesign Directive: '**ENTR Lot 6 – Air Conditioning and Ventilation Systems'.** The product scope is ventilation systems with individual fan power larger than 125 W. This implies systems that are commonly used in non-residential and collective residential applications.

This study is being carried out for the European Commission (DG ENTR). The consortium responsible for the study is Armines (lead contractor), BRE and VHK. Subcontractor for the underlying report is VHK.

Subtasks

The Terms of Reference for this contract Task 7 consist of:

subtask 7.1 Policy Analysis

The policy analysis should identify policy options considering the outcomes of all previous tasks, notably the options should:

- Be based on the exact definition of the products, according to subtask 1.1 and modified/confirmed by the other tasks;
- Provide ecodesign requirements, such as minimum (or maximum) requirements22, considering the sensitivity analysis carried out in subtask 6.4;
- Be complemented, where appropriate, with (dynamic) labelling and benchmark categories linked to possible incentives, relating to public procurement or direct and indirect fiscal instruments;
- Where appropriate, apply existing standards or propose needs/ generic requirements for harmonised standards to be developed;
- Provide measurement requirements, including measurement standards and/or methods;
- Consider possible self-regulation, such as voluntary agreement or sectoral benchmarks initiatives;
- Provide requirements on installation of the product or on user information.

As part of their policy scenario analysis contractors should provide a simple tool (e.g. in Excel), allowing estimates of the impacts on different scenarios and, to the extent possible, the estimation of Member State specific impacts.

Subtask 7.2 - Impact Analysis

For each of the policy options defined in subtask 7.1, the costs and benefits should be assessed.

In particular, the ecodesign requirements should not entail excessive costs nor undermine the competitiveness of European enterprises and should not have a significant negative impact on consumers or other users. This encompasses the assessment of the following impacts:

- Monetary impacts for categories of users in particular as regards affordability and life cycle cost of the product (confirming or modifying the results obtained in subtask 6.1);
- Impacts on the functionality of the product, from the perspective of the user;
- Monetary impacts on the manufacturer regarding redesign, testing, investment and/or production costs (confirming or modifying the results obtained in subtask 6.1);
- Further impacts on manufacturers, such as imposed proprietary technology or administrative burdens;
- Impact on the competitive situation of the market; such as market share of products already complying with the envisaged minimum requirement, market shares of remaining models after the minimum requirement is introduced, competitive advantage or negative impacts on the

Task 7 is performed in accordance with the various subtasks in the MEEuP methodology 2005.

The numbering of the chapters 1 and 2 in the underlying report follows the numbering of subtasks.

Inputs from previous tasks, continuity in subsequent tasks

Inputs for Task 7 are supplied by the preceding 5 Tasks:

- Task 1 supplies measurement methods (standards) and related existing legislation, e.g. the Ecodesign Fan and Motor regulations;
- Task 2 gives extensive data on prices and cost rates that are necessary for Life Cycle Cost (LCC)calculations, as well as EU sales and stock data that help to aggregate the outcomes per product to EU level;
- Task 3 describes typical loads, i.e. the ventilation demand, also as a function of sector, building type and occupancy;
- Task 4 defines the Base Case, i.e. the starting point for the LCC and impact calculation of the design options. It also defines the characteristics of the 5 product sub-categories: Central exhaust systems (CEXH), central balanced heat recovery ventilation (CHRV) as well as small, medium and large air handling units (AHU-S, AHU-M, AHU-L)
- Task 5 provides a technical analysis of existing ventilation systems, which will be used as the technical reference report for the design options that are modelled in Task 6.
- Task 6 gives
  - Least Life Cycle Costs (LLCC) levels per product subcategory, typically to be used as (minimum) targets for Ecodesign measures if this instrument is appropriate;
  - LLCC, BAT and BNAT levels, typically to be used –if this instrument is appropriate— in Energy Labelling as lower class limits for ‘C’, ‘A’ and ‘A+’ classes;
  - Levels of uncertainty of the assessments above following the sensitivity analysis;
  - Possible role of other instruments, outside Ecodesign and Energy Label, that could contribute in promoting products with a lower environmental impact (e.g. EPBD, procurement, Ecolabel, MS support schemes, etc.)

Task 7 concludes the preparatory study. The outcomes do not pre-empt legislation, but are intended to provide technical assistance to the Commission in the following political process of drafting measures in the Commission Working Documents. Furthermore they serve as an input to the Commission's Impact Assessment study.

Transparency and stakeholder participation

Through the project website www.ecohvac.eu, three formal stakeholder meetings and bilateral meetings with stakeholder experts, the contractors have tried to make the communication process and progress as transparent as possible. Information was gathered that is not only of a technical and economic nature but also of a more political nature. The ventilation industry is not a homogenous group of products and there are potentially conflicting interests amongst manufacturers. Furthermore, there are potentially conflicting interests between the industry and other stakeholders. The contractors have tried to take these issues into account.

1. Policy Analysis

1.1 Objectives

As laid out in previous Task reports, this product group is eligible for Ecodesign measures as it complies with the criteria of Art. 15 of the 2009/125/EC directive. It is economically and environmentally significant. There is a significant cost-effective saving potential that is not captured.

The table below gives the latest update of the key figures, already including the findings of the underlying Task 7.

The general objective is to develop a policy which corrects the market- and regulatory failures, which will be outlined in the next section.

As 99% of the environmental impact consists of the energy consumption and related emissions in the use phase, the specific objectives focus on the reduction of these substances following the Community environmental priorities, such as those set out in Decision 1600/2002, the Commission's European Climate Change Programme (ECCP). Furthermore, the promotion of energy efficiency aims to contribute to security of supply in the framework of the Community objective of saving 20% of the EU's energy consumption in 2020.

The Ecodesign Directive, Article 15, requires that ecodesign implementing measures meet all 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.

As regards the operational objectives it is clear that the 2020 time horizon, used in several overarching policy objectives for energy security of supply and environment, is very important. Savings in 2020, with respect to the reference year 1990, will indicate the relative contribution of measures.

Furthermore, relevant in view of the Commission roadmaps for 2050, the longer time horizon up to 2050 will also be taken into account.

1.2 Market and regulatory failures

The main market barriers hampering a larger market penetration of energy efficient Large Ventilation Units[1] were identified in the preparatory study and are as follows:

1. Lack of specific policy measures

Ventilation units are one those 'invisible' building products that mainly gain in popularity through regulation from authorities. In that sense, there is a huge disparity amongst Member States. In Scandinavia and the Netherlands heat recovery ventilation and the use of CO2 sensors is now common practice for ventilation in new buildings and also the conversion of the building stock is proceeding. In the UK, heat recovery ventilation is well known, but effectively it is waiting for stronger regulations to have the market really take off. In Germany, following EnEV 2009 and Wärmegesetz, the market is now more aware In Belgium and France the developments are just starting to develop. In Southern Europe heat recovery (and free cooling) is mainly considered as relevant for buildings with space cooling. Some Southern Member States have recently introduced measures in the context of their national building regulations that should further the use of efficient heat recovery ventilation. In Eastern EU Member States the interest in mechanical ventilation is extremely low if it is not linked with space cooling.

Specific measures

At a component level, actual and imminent Ecodesign regulations on fans and motors will have limited effect on Large Ventilation Units:

The Ecodesign Fan Regulation No. 327/11, will have little or no impact on large balanced ventilation unit energy efficiency, because fans in these units already operate at efficiencies that are higher than the minimum required. The most effect will be achieved in the heterogeneous exhaust ventilation units ('CEXH' category), where there are still plenty of fans working with inefficient motors and impellers.

Having said that, the Fan Regulation does provide useful metrics for fan efficiency for the best types (e.g. backward curved fans) and measures for Large Ventilation Units should seek to be consistent with these metrics.

The Ecodesign Commission Regulation No. 640/2009 on Motors >750 W, published d.d. 23.7.2009, will have –at least on the short run—little positive impact on ventilation unit energy efficiency, because it applies only to single speed motors. In ventilation units single speed motors are hardly used. Motor types are either 3-speed AC motors or EC-/DC motors with variable speed drive.

The imminent Ecodesign regulations and Energy Labelling measures for central heating boilers and water heaters (ENER Lots 1 and 2), currently in the process of Inter Service Consultation (ISC) could overlap with measures for Large Ventilation Units, in as much as the latter could deal with ventilation heat pumps. Ventilation heat pumps, contributing to space and/or sanitary water heating, have been identified in Task 6 as an economically very attractive and energy saving design option to realize heat recovery with exhaust ventilation systems (CEXH Base Case). Nonetheless, even though this option was identified as the Least Life Cycle Cost point it was treated with caution and not proposed as a universal target level for exhaust systems. One reason is that ventilation heat pumps cannot always be applied, e.g. if only a simple extraction task is foreseen in e.g. an industrial setting. But another reason is the overlap with Lots 1 and 2 measures, where it could be treated more comprehensively also in relation to other space and water heating options.

[1] 'Large Ventilation Units' is the name used in this report for ventilation units with a rated power >125 W per individual fans.

General legislation applicable to (certain types of) Domestic Ventilation Units

At a more general level, the possible use of bromated or chlorinated flame-retardants is tackled in the RoHS Directive (2011/65/EU, recast of 2002/95/EC), but from literature it is clear that these are not a 'hot' environmental issue.

The WEEE Directive (2002/96/EC) was set up to handle recovery/recycling of electronic and electrical waste, amongst which Large Ventilation Units. Given the recovery through the official channels, this seems fairly successful. But no particular design measures were found –apart from the usual[2]-- that would be particularly helpful in recovering and recycling of Large Ventilation Units.

The packaging of Large Ventilation Units has long been regulated through the Packaging directive (92/62/EC) and with the current practice of using components tied to pallets cannot be considered a priority environmental issue.

The Low Voltage Directive LVD (2006/95/EC) regulates electrical safety of Large Ventilation Units, but in terms of environmentally related issues the most relevant are references to harmonised standards on emissions of toxic materials under fault (on fire) conditions. For Large Ventilation Units the safety is regulated under the Machinery Directive (2006/42/EC) which came into force on 29 December 2009.

Other applicable legislation, all with very little bearing on the environmental impact, include the directive on Electromagnetic Compatibility EMC (2004/108/EC), the Batteries Directive (2006/66/EC) for Large Ventilation Units with battery powered features, the ATEX directive (94/9/EC) for Large Ventilation Units operating in potentially explosive atmosphere, possibly the Construction Products Directive (89/106/EC) for central ventilation systems and possibly specific directives on noise of appliances.[3]

2. Lack of appropriate measurement standards

Especially following various national and EU efforts in improving the energy performance of buildings test standards for Large Ventilation Units recently went through rather drastic updating with most EN standards having been developed in the last 5 years. These changes were much needed in view of the new role of Air Handling Units as a ventilation unit rather than a unit that provides air as a means of transporting cooling and heating to the building. At the moment, and not much before, it can be stated that standards are mature enough to be used in regulatory minimum requirements of Large Ventilation Units.

3. Comfort and habits

Although generally speaking mechanical Large Ventilation Units have a much higher overall energy efficiency than natural ventilation, it is often being perceived as less efficient than the 'natural way' of opening windows. As a result, these units are predominantly installed in buildings that provide space air cooling and not in buildings that have no space cooling or central air heating.

Another habit that is difficult to combat is the standard reaction of installers to replace 'like-for-like', i.e. to replace an old broken down rooftop ventilation unit with exactly the same, probably very inefficient type that was installed 17 years ago. Already the market for Large Ventilation Systems has a huge inertia, with large (passive) parts of the installation lasting as long as the building, i.e. 50 years, and very new buildings being commissioned. If then also the replace =ment of active components, such as the ventilation unit, do not trigger a change due to conservative installers this is highly detrimental for energy efficiency.

[2] E.g. design for disassembly, easy recovery of metals parts, avoid to use a mix of plastics that would make the product more difficult to handle in shredder-based recycling, etc. .

[3] The preparatory study mentions for outdoor leaf suction machines the Noise Emissions for Outdoor Equipment Directive (2000/14/EC).

4. Economics

Purchase price –within reason-- plays an important role in those countries where the legislator leaves some room to install cheaper, less efficient units. In those cases, heat recovery and fancy controls are the first to go, especially because the ventilation unit is one of the last building products to be installed. Price also plays a role for some of the newer technologies discussed, like CO2 sensors . Currently the market is at a stage where CO2 sensors and wireless communication are still sold at inflated prices. It is expected that these commercial prices will drop to more cost-related levels once volume and competition increases.

A related, well-known barrier to introduction of efficient building technology is the split between the builder and the tenants, with the former primarily interested in low building costs and the latter in lower energy costs. Although energy certification of buildings, the link of mortgage rates and rents to these energy labels, green public procurement, national energy efficiency action plans (NEEAPs), etc. are fighting against this inherent urge of builders to go for low-cost solutions, the urge is still there and very often still prevails.

Coupled with this is the relatively short time-horizon of builders. It is generally accepted that for an economic investment in energy efficient technology the horizon for payback is set at 20 years, even for components and installations such as ductwork, valves, etc. that last 50 years and even for components that will be replaced 'like-for-like' also over 50 years. A realistic estimate based on the actual product life of Large Ventilation Units would immediately make solutions such as heat recovery ventilation systems amongst the cheapest in the sector.

Another negative economic phenomenon is the fact that for buildings with higher energy consumption the energy rates also drop. Most utilities offer discount rates up to 40% for high volume energy-users, which has a negative impact on the payback of energy-efficient solutions in large buildings. On the positive side, the energy rates have risen to such a degree that even at heavily discounted energy rates the investments are still economical. Furthermore, at least for very large industrial users, the utilities appear now more aware of the downside of giving away energy at low prices while at the same time they are having trouble in building or acquiring enough power capacity.

5. Infrastructure

Centralized, ducted heat recovery units are very difficult/expensive to retrofit in existing buildings because of the ductwork. The newer easy-to-install local heat recovery units (not in the scope of this study) were introduced only recently and are still not well-known with builders and installers as a viable alternative. The same goes for ventilation heat pumps, which –as Task 6 shows—could be an attractive alternative for exhaust systems, but are currently only well known in Northern Europe.

1.3 Policy Options

Without specific measures the market- and regulatory failures would persist and it is to be expected that more individual Member States want to take individual non-harmonised action on Large Ventilation Unit efficiency. This would hamper the functioning of the internal market and lead to higher administrative burdens and costs for manufacturers, in contradiction to the goals of the Ecodesign Directive.

No initiative for self-regulation has been brought forward by the industry, most likely because of fear for 'free riders' and/or non-participants to a "self commitment".

Energy labeling is not an obvious choice as a policy option, because the Large Ventilation Units are planned and purchased by professionals. They are not exposed in shops, showrooms and very seldom the subject of print-advertising or publicity through the internet. Especially for large capacity units there is no intermediary between the manufacturer and the planner/builder/buyer. Product information requirements under Ecodesign would in that case at least as effective. Furthermore, certification by professional associations could help in instilling the confidence of these product information requirements.

The only sector where it would make sense to have labels on packaging could be on the smaller capacity products like exhaust fans ('CEXH') or integrated central heat recovery ventilation units ('CHRV'). For that group, a label on the packaging and in advertising could point the wholesale-retail/installer chain in the right direction.[4] This would also be the product groups of up to approx. 2500 m3/h design flow that would compete in the residential sector, where there could be a choice between a collective installation with units in the scope or individual small ventilation units that are in the scope of Domestic Ventilation Units as addressed under DG ENER Lot 10. It would also be a group that is distinct from the larger air handling units (AHUs) in the sense that certain extended products would also contain controls, sensors and actuators as a part of the package that is placed on the market.

Having said that, the setting of minimum Ecodesign requirements is still the obvious choice for the policy makers looking at this product group. Especially for the AHUs all test standards are in place to set requirements and perform market surveillance. Furthermore, verification of performance criteria is a frequent activity of buyers. The requirements could be set in two tiers, as is customary in other Ecodesign Regulations for professional products, with the first tier aiming to get the market actors used to the concept and the second tier, fully respecting the design cycle of 3-4 years after entry into force of the regulation, aiming at ambitious requirements.

The potential to cost-effectively improve the energy efficiency of Large Ventilation Units is large and estimated at 30-50%, depending on type, in Task 6. However, there is also a possibly even larger saving potential in replacing the very inefficient natural ventilation (infiltration, window opening) through efficient Large Ventilation Units. As has been argued in Task 6 mechanical ventilation is not only necessary in case of renovation and more comfortable, it is in most cases economically attractive even if it means introducing ductwork, grilles, etc. in the building installation. For the switch from natural to mechanical ventilation Ecodesign, which addresses individual products, is not the appropriate instrument. But it could be complementary to lateral policy measures such as the energy performance of buildings directive (EPBD), green public procurement (GPP), national energy efficiency action plans (NEEAPs). As was shown in Task 3, especially in the (semi-) public sector buildings are lagging behind in employing efficient mechanical ventilation. Renovating the public building stock at a pace of 3% per year, as is proposed in the new Energy efficiency Directive, could be one of the drivers for efficient ventilation. This could be promoted directly through specific guidelines/rules or indirectly , i.e. as a 'rule-of-thumb' if more than one-third of the windows renovated –a very popular renovation measure-- than mechanical ventilation becomes necessary if not for anything else than for health reasons (Indoor Air Quality IAQ).

1.4 Scenarios

1.4.1 Base Case

Based on the previous sections, the findings of Task 6 and stakeholder inputs, a number of options for technical requirements are selected for the scenario calculation in Chapter 7.2.

[4] Compare e.g. energy labeling with circulator pumps.

Starting point are the Base Cases as defined in Task 4 (Base Cases), as summarised below for the sales 2010.

Table 7-1. Estimated space heating saving non-residential ventilation units, sold 2010

Product -->	Ref. natural vent.	CEXH	CHRV	AHU-S	AHU-M	AHU-L
design flow rate q_{design} (m³/h)	X	1 500	2 250	4 000	10 000	35 000
---includes MISC factor	*1.7*	*1.33*	*1.10*	*1.10*	*1.15*	*1.18*
---effective flow rate for IAQ q_{eff}	*X/1.7*	*1 128*	*2 045*	*3 636*	*8 695*	*29 661*
Filter Yes (=1) or No (=0)	0	0	1	1	1	1
Aggregate thermal efficiency η_{th} in %	0	0	0.8	0.44	0.44	0.44
HR market penetration HR_{pen}	0	0	1	0.7	0.7	0.7
On/off control factor $CTRL_{on}$	0.8	0.8	0.6	0.6	0.6	0.6
Speed control factor $CTRL_{var}$	1	0.8	0.8	0.8	0.8	0.8
Airflow annual average q_a (m³/h)= $CTRL_{on}$ * $CTRL_{var}$*q_{design}	0.8*1*X	960	1 080	1 920	4 800	16 800
A. Reference natural ventilation, heating energy loss: (22.22 or 10.05 or 43.47) * 1.36 * q_{eff}						
Average climate (kWh/a)		34 087	61 798	109 877	262 786	896 332
Warmer Climate (kWh/a)		15 418	27 951	49 697	118 857	405 407
Colder climate (kWh/a)		66 686	120 899	214 957	514 101	1 753 535
B. Mechanical ventilation, heat energy loss: (22.22 or 10.05 or 43.47)*q_a *(1- η_{th})						
Average climate (kWh/a)		21 331	4 800	23 891	59 727	209 046
Warmer Climate (kWh/a)		9 648	2 171	10 806	27 014	94 550
Colder climate (kWh/a)		41 731	9 390	46 739	116 847	408 966
C. Mechanical ventilation with HR, preheat primary energy: (0.35 or 0 or 4.48) * q_a * HR_{pen}						
Average climate (kWh/a)		0	378	470	1 176	4 116
Warmer Climate (kWh/a)		0	0	0	0	0
Colder climate (kWh/a)		0	4 838	6 021	15 053	52 685
Heating energy saved (A – B – C)						
Average climate (kWh/a)		12 756	56 622	85 518	201 880	683 170
Warmer Climate (kWh/a)		5 768	25 781	38 892	91 841	310 856
Colder climate (kWh/a)		24 949	106 673	162 202	382 196	1 291 884
Average climate in %		*37.4%*	*91.6%*	*77.8%*	*76.8%*	*76.2%*
Warmer Climate in %		*37.4%*	*92.2%*	*78.3%*	*77.3%*	*76.7%*
Colder climate in %		*37.4%*	*88.2%*	*75.5%*	*74.3%*	*73.7%*

Table 7-2. Estimated electricity use non-residential ventilation units, sold 2010

Product -->	CEXH	CHRV	AHU-S	AHU-M	AHU-L
design flow rate q_{design} (m³/h)	1 500	2 250	4 000	10 000	35 000
---includes MISC factor	*1.33*	*1.10*	*1.10*	*1.15*	*1.18*
---effective flow rate	*1 128*	*2 045*	*3 636*	*9 091*	*31 818*
Filter Yes (=1) or No (=0)	0	1	1	1	1
Avg. thermal efficiency η_{th} in %	0	80	44	44	44
design ΔPext (in Pa)	154	181	244	450	575
design ΔPint (in Pa)	37	329	292	334	391
Number of fans per unit	1	2	2	2	2
Power output Pvent in W	80	638	1 191	4 356	18 788
SFP unit (in W/(m³/s))	1 080	1 620	1 980	2 700	3 420
Design el. power $P_{eldesign}$ (in W)	345	1 013	2 200	7 500	31 500
Design fan system efficiency	*23%*	*63%*	*54%*	*58%*	*61%*
On/off control factor $CTRL_{on}$	0.8	0.6	0.6	0.6	0.6
Speed control factor $CTRL_{var}$	0.8	0.8	0.8	0.8	0.8
Annual avg. el. power P_{ela}(in W)	151	346	752	2 564	10 768
Annual electricity/a (kWh_e/a)	1 327	3 032	6 588	22 459	94 327

Task 4 shows in the environmental impact analysis that over 99% of CO2-emissions and energy, 97-99% of SOx emissions, 97-98 of VOC emissions and 33-55% of particulate matter emissions relate to the energy use in the use phase.

Task 4 also provides sales and stock 2010 stock data. They are discussed in the following paragraphs and set against the reality checks from top-bottom analyses to find the figures that are used in the scenario analysis. Baseline (BaU) data are in the Annex I of the underlying report.

Noise

One environmental aspect that has been identified as significant for ventilation is noise. However, as non-residential ventilation units are usually in technical spaces or on the roof and not in the spaces to be ventilated, noise is less significant. The noise problem is typically solved to a considerable extent at the system level (ductwork, grills) through silencers and sound dampers. Possible exceptions are industrial and very large AHUs, where –as mentioned—the problem of meeting the regulated noise limits is solved holistically (system level). Another exception are ceiling mounted CHRVs, which are placed in the plenum of small commercial spaces.

Indoor noise is particularly important if it is in or close to habitable spaces. In that sense it is illustrative to look at the discussion on ENER Lot 10, which treats domestic ventilation units. For domestic ventilation units, noise requirements are defined in EN 13141-6 to -8 and EN 13142 with reference to acoustics measurement standards[5] . The acoustic measurement of un-ducted units or noise radiated from casings requires installation of the unit in a test room shall be carried out according to engineering methods described in EN ISO 3743-1 or EN ISO 3743-2 (reverberation room), EN ISO 3744 (free field) or EN ISO 9614-1 or EN ISO 9614-2 (sound intensity) or according respectively to the following precision methods described in EN ISO 3741, EN ISO 3745 or EN ISO 9614-1. It would be difficult to transfer the measurement standards to non-residential ventilation units.

The draft working document for ENER Lot 10, proposed December 2010, defines a product information requirement for noise, formulated as *'airborne acoustical A-weighted sound power emissions expressed in dB(A) re 1 pW and rounded to the nearest integer at design flow rate, for ducted units determined from in-duct radiative sound power measurements and for unducted units and hoods determined as radiative sound power of the casing.'* Furthermore, the proposed draft Ecodesign requirement for residential units mentioned sound power of no more than 50 dBa re 1pw at reference conditions.

In a reaction[6], no consensus amongst Member States could be reached as to what is an acceptable level. There was a fear that once a certain noise level is determined in Ecodesign that this could then override or negatively influence the noise requirements in national building regulations. The comments by the industry show at least reluctance from the part of industry to include stringent noise level requirements. Noise is one of the most complex issues to deal with in engineering design.

In conclusion, the study team believes that noise requirements should not be part of the Ecodesign requirements for non-residential ventilation units, but recommends to follow this further when discussing possible sound power level requirements for domestic ventilation units, and considering possibly transferable sound power level requirements, measurements and calculations, benchmarks and information requirements for related HVAC products in Ecodesign regulations adopted and/or under development.

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[5] For instance: EN ISO 3741, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for reverberation rooms*

EN ISO 3743-1, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for small, moveable sources in reverberant fields — Part 1:Comparison method for hard-walled test rooms*

EN ISO 3743-2, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering methods for small, moveable sources in reverberant fields — Part 2: Methods for special reverberation test rooms (ISO 3743-2:1994)*

EN ISO 3744, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Engineering method in an essentially free field over a reflecting plane (ISO 3744:1994)*

EN ISO 3745, *Acoustics — Determination of sound power levels of noise sources using sound pressure — Precision methods for anechoic and semi-anechoic rooms*

EN ISO 9614-1, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 1: Measurement at discrete points*

EN ISO 9614-2, *Acoustics — Determination of sound power levels of noise sources using sound intensity — Part 2: Measurement by scanning*

EN ISO 10140-1, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 1: Application rules for specific products*

EN ISO 10140-2, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 2: Measurement of airborne sound insulation*

EN ISO 10140-5, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 5: Requirements for test facilities and equipment*

ISO 717-1, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation*

[6] The ENER 10 Draft Working Document and stakeholders' reaction can be found on the Commission's circa websit or on various public sites as e.g. http://www.eceee.org/Eco_design/products/domestic_ventilation

1.5 Policy scenarios

As required by the ToR, sets of policy options are formulated that will serve as an input to the policy scenarios. To a large extend the three sets of policy options contain common elements. Mainly as regards the specific requirements for the environmental/resources impacts there is a differentiation.

1.5.1 Product Definitions

The products in the scope and the categories therein are based on the exact definitions as formulated in subtask 1.1:

The products covered in this report are mechanical ventilation units with an electric power input per individual fan larger than 125 W.

Mechanical ventilation units means products that provide the exchange between relatively clean outdoor air and polluted indoor air of a (part of a) building to create a healthy Indoor Air Quality (IAQ) for its inhabitants and building construction.

Categories of mechanical ventilation units are

- Central *EXHaust* or *supply* units (CEXH), which means mechanical ventilation units realizing mechanical air extraction from the building (or mechanical air supply to the building), whereby the air supply (or exhaust) is realized by separate natural ventilation openings in the building shell;
- central *balanced* units, which means mechanical ventilation units providing both the air exhaust and air supply mechanically, subdivided in
  - o *Central Heat Recovery Ventilation* units (CHRV), which means central balanced units dedicated to deliver heat recovery only;
  - o *Air Handling Units* (AHU), which means central balanced units, with or without heat recovery, that are predisposed to also contain a section with one or more cooling and/or heating heat exchangers (a.k.a. 'coils').

Not included are:

Technical ventilation units dedicated to application in mining, hospital operating rooms and high-temperature applications.

Note that for the first set of options ('Scenario 1') the definition of CEXH deviates from the above, following the industry position.

1.5.2 Ecodesign requirements, common elements

Taking into account the typical design cycle (platform) and the sensitivity analysis carried out in subtask 6.4 and the findings as regards self-regulation in Task 1, the following common elements in the Ecodesign requirements for the policy options are proposed:

Self-regulation

As mentioned under Task 1, there are no initiatives, nor any proposals by industry for initiatives that could replace mandatory regulation of Ecodesign requirements for the products in the scope. Hence, all policy options are based on the introduction of legislation in the form of a Commission Regulation under 2009/125/EC, Annex II (specific requirements).

Staging: 2-tier approach

A common element in all sets of options is a 2-tier approach. The first tier is mainly intended to give market actors a chance to gain experience with the procedure and logistics on the market. The ambition level of first tier is intentionally low, i.e. typically in line with what is in place at the level of Member States. The latter enables the legislator to be more ambitious in the timing than the design cycle would strictly allow.

The second tier aims at an ambitious level of savings.

Timing

The customary timing of Ecodesign measures for these types of professional products is to set the timing of tier 1 one or two years after the entry into force of the legislation and to imoplement tier 2 two years after that.[7] For instance, if measures enter into force in 2013 the most ambitious timeline would be to implement tiers 1 and 2 in 2014 and 2016 respectively. A more relaxed approach would be to introduce tiers 1 and 2 in 2015 and 2017 respectively. A review date for measures would be set typically 4 or 5 years after entry into force, i.e. in 2017 (after implementation of tier 2) or 2018.

Compare e.g. the Ecodesign Fan regulation Nr. 327/2011 which entered into force in 2011 with the implementation of tiers 1 and 2 in 2013 and 2015 respectively. Note that the tier 2 of the Fan Regulation will probably more or less coincide with tier 1 of any Ecodesign measures for Large Ventilation Units. For a coherent legislation it is imperative that the proposed measures for ventilation units are synchronized with the requirements of the Fan Regulation 327/2011.

Benchmarks

There are benchmarks for the products provided by the Eurovent certification scheme ('A' class highest), the RLT certification scheme ('A+' class), as well as benchmarks for all individual aspects, as described in Task 1 (par. 2.6), amongst others the SFP classification for the electricity consumption of the unit. The results of these classifications are included in the Product Information Requirements. Given the fact that this is a professional market, this should be sufficient for government incentives or green public procurement that aim for the best.

Product Information Requirements

A comprehensive list of parameters for product information requirements, common to all 3 sets of policy options, is provided in Annex II. The list is extensive, but not unusual for the sector and would not significantly increase the administrative burden of the industry.

Measurement and calculation methods

The measurement and calculation methods for the product information requirements are indicated in Annex II. Predominantly the EN 13053/A1:2010 (included referenced standards e.g. EN 308:1997) and the Ecodesign Fan Regulation 327/2011 as well as the standards (implicitly) implied therein such as EN ISO 5801 and EN ISO 12759 apply.

For classification of features prEN 13141-8: 2011 and EN 779:2012 (filters) applies. For comparison the EN 13799:2007 (SFP and SFP class), the Eurovent Certification methodology (A..G) and the RLT certification class methodology (B..A+) are to be used.

The EN 15251 recommendations (once it is clarified, as discussed in Annex III with REHVA-chair) can be used for general user information on ventilation rates.

[7] For installed products, produced in series, the milestones for R&D are international biennial trade fairs like the ISH Frankfurt or Mostra Convegno in Milan (IT) as well as national trade fairs of building products. In practice this means that manufacturer present new products every 2 years and that –apart from some 'classics'—the most part of the catalogue is replaced every 4 years. The larger Air Handling Units are modular and often built strictly on customer-specifications , actually allowing more flexibility in selecting new components.

The measurement and calculation methods for the minimum or maximum Ecodesign requirements are indicated in the following paragraph.

1.5.3 Specific Ecodesign Requirements

Following the Least Life Cycle Cost (LLCC) targets as calculated in Task 6 as well as the discussions with stakeholders, as documented in Annex III, three sets of minimum requirements

1. Set of requirements based on industry proposals received before the stakeholder meeting of 16 April 2012 (see Annex III);
2. Set of requirements based on Task 6 findings, i.e. the Least Life Cycle Costs;
3. Set of requirements based on a balance of ambitious technical requirements and compromise solutions where there could be a negative impacts, this includes a reaction to comments from stakeholders after the stakeholder meeting of 16 April 2012.

The first set of requirements is the least ambitious (Scenario 1). The second set of requirements is the most ambitious (Scenario 2). The third set of requirements is an intermediate set of requirements between the first and second set (Scenario 3).

1.5.4 Policy scenario 1

CEXH

Definition: Products in which any fan or motorised impeller is built in without any thermodynamic air treatment or additional physical (for example filtration) air treatment and is not a component of a ventilation unit. There is a distinction between 'box fans', intended for indoor mounting, and 'rooftop fans', intended for outdoor mounting.

Minimum efficiency requirements for fan in unit: Regulated only by Fan Regulation 327/2011 (no additional requirements)

Minimum efficiency requirements for the unit (fan+casing): using the same methods as proposed in Ecodesign Regulation 327/11, for rooftop and boxed ventilator units the minimum target energy efficiency as set out in the Table below. The test is to be conducted for units, without possible provisions for thermodynamic air treatment or filters.

Table 7- 3. CEXH minimum energy efficiency requirements

Fan types	Measurement category (A-D)	Efficiency category (static or total)	Target energy efficiency η_{target}* with P=nominal electric power input (top formula per category applies to P<10 kW and lower formula to P>10 kW)	Efficiency grade N Tier 1 (2014)	Efficiency grade N Tier 2 (2016)
Box fan with backward curved or mixed flow fan	B, D	total	η_{target} *= 4.56 · ln(P) – 10.5 + N η_{target} = 1.1 · ln(P) – 2.6 + N	35	39
Box fan with forward curved or axial fan	B,D	total	η_{target} = 2.74 · ln(P) – 6.33 + N η_{target} = 0.78 · ln(P) – 1.88 + N	25	28
Roof fan (axial fan within)	A, C	static	η_{target} = 2.74 · ln(P) – 6.33 + N η_{target} = 0.78 · ln(P) – 1.88 + N	27	31
Roof fan (centrifugal or mixed flow fan within)	A, C	static	η_{target} = 4.56 · ln(P) – 10.5 + N η_{target} = 1.1 · ln(P) – 2.6 + N	38	42

**= η_{target} is an integer number that should be applied as % (factor 0.01)*

No other requirements apply.

CHRV & AHUs

Definition: As given in par. 1.5.1

Minimum efficiency requirements for fans in unit: The fans applied in the units must meet the following target efficiencies η_{target}, as defined in Fan Regulation 327/2011 for categories B and D [8]

Between 1.1.2014 and 1.1.2015:

η_{target} =4.56%*ln(P) – 10.5% + **61%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **61%** for P>10 kW

After 1.1.2015

η_{target} =4.56%*ln(P) – 10.5% + **64%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **64%** for P>10 kW

Where P is the nominal electric power input of the fan in kW.

Minimum efficiency requirement heat recovery:

The minimum requirement for heat recovery energy efficiency η_e is **55%** in Tier 1 (2014) and **64%** in Tier 2 (2016), whereby the energy efficiency η_e is defined as follows:

$$\eta_e = \eta_t * (1 - 1/\varepsilon)$$

where

- η_e is the energy efficiency of the Heat Recovery System HRS [-],
- η_t is the thermal efficiency of the HRS [-], where

$$\eta_t = (t_2'' - t_2')/(t_1' - t_2')$$, with

  - t_2'' is temperature of the supply air leaving the HRS and entering the room [°C]
  - t_2' is temperature of the outside air [°C]
  - t_1' is temperature of the exhaust air, leaving the room and entering the HRS [°C]

- ε is the coefficient of performance [-], where

$$\varepsilon = Q_{HRS} / P_{el}$$, with

  - Q_{HRS} is the capacity of the heat recovery system [W], where

$$Q_{HRS} = q_m \bullet c_{pA} \bullet (t_2'' - t_2')$$, with

    - q_m is the mass flow of the air [kg/s] (air density, by convention: 1.2 kg/m³);

[8] The requirements correspond to those of backwards curved fans in Fan Regulation 327/2011 in category B and D [note that the industry agreed to prescribing backward curved fans], but the formulation is chosen because it is technology-specific and would allow also other fan types if they meet the requirements.

— c_{pA} is specific thermal capacity [kJ/kg K] (dry air ca. 1 kJ/kg K);
— $(t_2'' - t_2')$ is the difference between supply and outdoor air temperature [K]

— P_{el} is the electric power consumption attributed to the pressure loss of the heat recovery system [W], where

$$P_{el} = q_v \bullet \Delta p_{HRS} / \eta_D + P_{el\,aux}$$, with

— Δp_{HRS} is the sum of pressure loss [Pa] at supply side and exhaust side of the heat recovery system with $\Delta p_{HRS} = \Delta_{supply} + \Delta_{exhaust}$
— η_D is 0.6 is the efficiency [-] of electric power generation (EN 13053)
— $P_{el\,aux}$ is the auxiliary electric power consumption [W], e.g. of circulation pump in a run-around system.

Note that the formula for η_e promotes both a high thermal efficiency η_t and a low pressure loss Δp_{HRS} (determining part of ε) of the heat recovery system.

Thermal efficiency η_t is determined according to EN 308:1997, i.e. with reference testing conditions entailing dry exhaust 'indoor' air t_1' at 25 °C dry bulb temperature (wet bulb temperature 18 °C for regenerative hygroscopic recovery devices, <14 °C for other types) and dry 'outdoor' air t_2' supplied to the heat recovery system on the supply side at 5 °C dry bulb temperature (for regenerative hygroscopic recovery devices 3 °C wet bulb temperature) , with no influence of fan motor waste heat during the test. The test procedure consists of 7 tests at the following combinations of supply (q_{m2}) and exhaust(q_{m1}) air flows:

qm2	qmn	0,67 qmn	1,5 qmn	0,67 qmn	qmn	qmn	1,5 qmn
qml	qmn	qmn	qmn	0,67 *qmn*	0,67 qmn	1,5 qmn	1,5 qmn

Wher q_{mn} is the nominal air flow. Thermal efficiency is the non-weighted average of the test results.

The pressure drop of the heat recovery system Δp_{HRS} is the sum of supply side and exhaust side pressure drops Δp_2 and Δp_1, determined according to EN 308:1997. Static pressure drops shall be measured, and dynamic pressure calculated, both sides of the recovery device for the 7 different air flow rate combinations mentioned above. The pressure drops Δp_2 and Δp_1 are the non-weighted averages of the individual 7 test results.

Further stipulations regarding test conditions, allowed leakages, tolerances, etc. can be found in EN 308:1997.

Filter mounting requirements: If a filter module is required—the product shall be able to mount an **F7** filter with low pressure drop (e.g. 'A' according to Eurovent filter classification). The commercial filter product to be used for compliance assessment shall be indicated.

No additional requirements apply.

Note that in the final stakeholder comments Scenario 1 encountered little enthousiasm both from government representatives and professional organisations. See Annex III for details.

1.5.5 Policy scenario 2

This set of requirements is strictly based on the outcomes of Task 6, i.e. an implementation of the LLCC design options at the level of Tier 2.

For CEXH the Task 6 analysis these design options are 1b+4b, which means the highest fan efficiency (48% for the Base Case, but generally following the Fan Regulation equation) in combination with control options at least equivalent to remote clocked controls and/or central sensors.

For the CHRV Task 6 indicates an LLCC level at options 1+2+3+4b. This means a combination of measures on all aspects: higher fan efficiency, lower internal pressure drop, improved heat recovery (from declared 80% to real 80% or to declared 90%) and possibly integrated controls or at least variable speed drive.

For AHUs the LLCC design options 1+2b+3 are the same for all sizes: highest fan efficiency class, lower internal pressure (=lower face velocity, low filter pressure drop when applied), heat recovery and variable speed drive mandatory, heat recovery at least at level H1 (EN 13053 method).

Requirements for all products

Definition: As in par. 1.5.1

Minimum efficiency requirements for fans in unit: The fans applied in the units shall meet or exceed the following target efficiencies η_{target}, as defined in and tested in accordance with the stipulations in the Fan Regulation 327/2011 [9]

Between 1.1.2014 and 1.1.2015:

η_{target} =4.56%*ln(P) – 10.5% + **58%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **58%** for P>10 kW

After 1.1.2015

η_{target} =4.56%*ln(P) – 10.5% + **62%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **62%** for P>10 kW

Where P is the nominal electric power input of the fan in kW.

Minimum speed control requirements for fan-drives: In Tier 1 (2014) the units must be equipped with either a multiple speed pre-set with at least 3 equidistant speed settings over the range[10], or variable speed drive (continuous) . The minimum speed setting must be at the most 40% of the nominal speed.

In Tier 2 (2016) the units must be equipped with either a multiple speed pre-set with at least 5 equidistant speed settings over the range[11] , or a variable speed drive (continuous) . The minimum speed setting must be at the most 20% of the nominal speed.

[9] The requirements correspond to those of backwards curved fans in Fan Regulation 327/2011 in categories A and C, but the formulation is chosen because it is technology-specific and would allow also other fan types if they meet the requirements.
[10] With a tolerance of ±10%
[11] With a tolerance of ±10%

CEXH

Minimum efficiency requirements for units (fan+casing): The units shall meet or exceed the following target efficiencies η_{target}, as defined in and tested in accordance with the stipulations in the Fan Regulation 327/2011 according to the appropriate categories. The test is to be conducted for whole units, without possible provisions for thermodynamic air treatment or filters.

Between 1.1.2014 and 1.1.2015:

η_{target} =4.56%*ln(P) – 10.5% + **50%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **50%** for P>10 kW

After 1.1.2015

η_{target} =4.56%*ln(P) – 10.5% + **54%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **54%** for P>10 kW

Where P is the nominal electric power input of the fan in kW.

Minimum control requirements for the units: In Tier 2 (2016), the unit must be equipped with

A clocked (daytime-controlled) human interface to control the fan speed/ flow-rate of the ventilation unit, with at least 7 weekday manual settings of the adjustable flow-rate for at least 2 or more setback periods, i.e. periods where a reduced or no flow rate applies.

OR (exhaust units only)

A *'Central Sensor'*, defined as a measurement device that is part of the ventilation unit, which measures chemical-physical characteristics of the extracted air flow that are indicative of the human occupation rate[12] and the emission of excessive humidity in the spaces of the building which are intended to be ventilated by the ventilation unit and which provides –directly or indirectly—a signal to a device controlling the flow rate, in order to adjust the flow rate of the unit in accordance with the adjustable settings[13] for the signal processing [14]

OR (exhaust or supply units)

'Local Sensors', defined as one or more measurement devices, not necessarily physically incorporated in the ventilation unit but possibly part of the product configuration placed on the market, that are capable of assessing the human occupation rate[15] and the emission of excessive humidity in at least three different spaces that intended to be ventilated by the ventilation unit and that are capable of communicating their assessments to devices, also part of the product (package) placed on the market, that regulate the fan speed and individually regulate the flow rates to said spaces.[16]

[12] 'Rate' means not only if the spaces are occupied but also the number of occupants. Typically realized through a CO2-sensor.
[13] Typically dip-switches
[14] Previously known as 'Central CO2 & RH sensor'
[15] 'Rate' means not only if the space is occupied but also the number of occupants. Typically realized through a CO2-sensor or multiple (e.g. infrared) occupancy sensors.
[16] Previously known as 'Local CO2 & RH sensors + VAV boxes' (VAV= Variable Air Volume)

CHRV & AHUs

Definition: As given in par. 1.5.1

Heat recovery requirement: All balanced units shall be equipped with a heat recovery system, including a bypass for free cooling.

Minimum electric efficiency requirement for the unit: The maximum electric power consumption of the unit in kW shall not exceed in Tier 1 (2014) a value of **0.90****Pmref*** and in Tier 2 (2016) a value of **0.85****Pmref***, whereby ***Pmref*** is defined as

$$Pmref = \left(\frac{\Delta p_{stat}}{450}\right)^{0,925} * (q_v + 0,08)^{0,95}$$

where

— *Pmref* is the reference power consumption [kW];

— Δp_{stat} is external static pressure [Pa];

— q_v is airflow [m³/s].

Δp_{stat} and q_v are determined at the reference working point, which is assumed to be at b.e.p. (best efficiency point) or at 65-70% of the design (declared maximum) air flow.

Minimum face velocity requirement for the unit is **1.8 m/s** for Tier 1 (2014) and **1.6 m/s** for Tier 2 (2016), whereby face velocity shall be measured at the effective front filter surface or –for units without filter module— front surface of smallest free casing section (in accordance with EN 13053).

Minimum efficiency requirement heat recovery: The minimum requirement for heat recovery energy efficiency η_e is **64%** in Tier 1 (2014) and **71%** in Tier 2 (2016), whereby the energy efficiency η_e is defined as indicated in paragraph 1.5.4 (Policy Scenario 1).

Filter mounting requirements: In Tier 2 (2016), if a filter module is required—the product shall be able to mount an **F7** [17] filter with low pressure drop (e.g. 'A' according to Eurovent filter classification[18]). The commercial filter product to be used for compliance assessment shall be indicated.

Filter change warning: In Tier 2 (2016) mandatory visual signaling of filter pressure drop exceeding maximum final pressure drop, i.e. 200 Pa for F7 filter, 300 Pa for F8 and better.

Maximum leakage requirements: In Tier 2 (2016), the ventilation unit shall have a maximum leakage of

- **10%** for the casing **external leakage** (casing to the outside) according to pressurization test method or **6%** according to the tracer gas method
- **10%** for the casing **internal leakage** (between extraction and supply side) according to pressurization test method or **6%** according to the tracer gas method

[17] According to prEN 779:2012. Text to be expanded with detailed description in legislation or transitional method.

[18] Filters are tested according to Eurovent recommendation 4/11: at EN 779 conditions, i.e. at air flow of 0.944 m3/s, filter face 0.592 x 0.592 m (face velocity 2,7 m/s), and while –for fine filters-- loading 100 g of appropriate ASHRAE test dust the filter's pressure drop is measured at least at 5 different points in time until 100 g of test dust is loaded or a maximum pressure drop of 450 Pa is reached. Through 4tht order polynomial curve fitting the average pressure drop $\overline{\Delta p}$ is assessed. Using 50% fan efficiency, 6000 operating hours and an airflow of 0.944 m3/s the annual electricity consumption W= 11.32 * $\overline{\Delta p}$ in kWh/a is determined. The class limit for the "A" class with F7 filters in this scheme is set at 1200 kWh/a, which means at around an average pressure drop of 105 Pa.

- Approval after visual inspection (Classification **FLB4**) of **filter bypass leakage** (air passing between filter-holder & casing and filter-holder & filter.

In case the in- and outlet ducts of the ventilation unit to the outdoors and their relative position are a fixed or prescribed part of the ventilation unit package, the maximum **recirculation flow** at nominal air flows shall not exceed **6%** according to the tracer gas method.

Depending amongst others on the design pressure of the unit there are several measurement standards available, e.g. EN 13141, EN 1886 and EN 308. The Commission with stakeholders will have to make a final selection.

1.5.6 Policy Scenario 3

The requirements in this scenario are identical to the ones in Policy Scenario 2 with the following amendments:

CEXH:

Minimum efficiency requirements for fans in unit: The fans applied in the units shall meet or exceed the following target efficiencies η_{target}, as defined in and tested in accordance with the stipulations in the Fan Regulation 327/2011 [19]

Between 1.1.2014 and 1.1.2015:

η_{target} =4.56%*ln(P) – 10.5% + **53%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **53%** for P>10 kW

After 1.1.2015

η_{target} =4.56%*ln(P) – 10.5% + **57%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **57%** for P>10 kW

Where P is the nominal electric power input of the fan in kW.

Minimum efficiency requirements for units (fan+casing): The units shall meet or exceed the following target efficiencies η_{target}, as defined in and tested in accordance with the stipulations in the Fan Regulation 327/2011 according to the appropriate categories. The test is to be conducted for whole units, without possible provisions for thermodynamic air treatment or filters.

Between 1.1.2014 and 1.1.2015:

η_{target} =4.56%*ln(P) – 10.5% + **45%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **45%** for P>10 kW

After 1.1.2015

η_{target} =4.56%*ln(P) – 10.5% + **50%** for P≤10 kW

η_{target} =1.1%*ln(P) – 2.6% + **50%** for P>10 kW

Where P is the nominal electric power input of the fan in kW.

[19] The requirements correspond to those of backwards curved fans in Fan Regulation 327/2011 in categories A and C, but the formulation is chosen because it is technology-specific and would allow also other fan types if they meet the requirements.

Note: This would allow a larger share of the best non-backwards curved fans, i.e. the cross-flow and best forward-curved fans, to stay in the CEXH application.

CHRV & AHU

Only for units with individual fan power P>10 kW

Minimum efficiency requirement heat recovery: The minimum requirement for heat recovery energy efficiency η_e is **64%** in Tier 1 and 2 (2014 and 2016), whereby the energy efficiency η_e is defined as indicated in paragraph 1.5.4 (Policy Scenario 1).

Note: In case of strict requirements of 0% cross-contamination such as in laboratories (hospitals, chemical labs, etc.), the normal rotary, counter-flow (let alone cross-flow) heat exchangers cannot be used and it would necessitate the use of run-around coils, for which it is difficult to meet a heat recovery energy efficiency of 71%. Furthermore, run-around coils may be necessary in retrofit or renovation projects where the ductwork originally was laid out for two separate fans in separate parts of the buildings. In theory, it is possible to create exceptions in the legislation for these cases. In practice, it represents a significant administrative burden and is hard to check for compliance whether indeed 0% cross-contamination is realistic or whether indeed it would be economically impossible to bring together the extract and supply ductwork in a building renovation. For that reason, but only for larger units (individual fan power >10 kW) this amendment would allow a lower heat recovery.

Setting the heat recovery requirements at a lower level reduces the savings on space heating, but it also has a beneficial effect on the electricity consumption because of the lower internal pressure drop.

Minimum face velocity requirement for the unit is **1.8 m/s** for Tier 1 and Tier 2 (2014 and 2016) , established as indicated in par. 1.5.5. (Policy Scenario 2).

Note: Especially for the larger units (individual fan power >10 kW) the requirement on face velocity of 1.6 m/s leads to a large increase of the volume of the casing, which makes the unit expensive and sometimes difficult to retrofit. As a result, potential clients might put of renovation/retrofit and keep repairing/ changing modules of the old installation. This 'rebound' effect could probably largely be avoided by setting slightly leaner requirements. Remember that current face velocities are in the range of 2.5-3 m/s and thus 1.8 m/s is still a significant improvement.

1.6 Stock model and policy scenarios

1.6.1 Introduction

The ToR requires a 'simple' model, possibly for each Member State, whereas the MEEuP, which is to be used as a guidance, requires a full-blown stock model to calculate policy scenarios, which is anything but simple, even if it is done for the whole of the EU.

Amongst others from the poor data availability that was indicated in all the previous Task reports it must be clear that it is not possible to make a model for each Member State.

The study team, in consultation with the Commission, has decided to develop a stock model for the environmental/ resources impacts of the various scenarios. In the next chapter on the impact analysis the stock model was extended to indicate the monetary impacts in terms of user expenditure and business revenues.

The scenario analysis means a projection of the impacts of various scenarios for the environment, industry measures for larger ventilation units is much more complex than for other energy-related products, because

- It has both a direct impact, the electricity consumption of the unit, and an indirect impact, the space heating energy to fight the ventilation losses;
- The 'extended product approach' can only partially be applied. Small capacity products are placed on the market integrated with controls and heat recovery. Large capacity products basically have a modular and the design options involving controls do not apply.
- The technical modelling is not simple. Most design parameters are interconnected. Some relationships are not linear, like speed control or face velocity. Sometimes the impacts are moving in the same direction, like with the control options which are beneficial for both saving on electricity and space heating energy. Sometimes the impacts are moving in opposite directions, e.g. the addition of heat recovery also means a penalty in terms of higher internal pressure drop and thus a higher electricity consumption.
- The installation materials and labour costs make up the largest part of the acquisition costs, which means that –in order to provide a clear picture—the monetary impacts have to be judged in increments rather than absolute figures.
- Economical calculations had to be simplified to a single 17 year product life. In real life there is a whole range of product lives to consider, ranging from 10 years for certain low-cost smaller units up to products and components that last as long as the building. This makes it difficult to find an exact match between modelled data and real data.
- Data availability is poor, both as regards market data as well as product features. The exception is the German market, where manufacturer's associations and the university of Trier have made a large effort in creating transparency. But for the rest of Europe this is certainly not the case. And even in Germany the information is incomplete, as the smaller units are largely outside the focus of the manufacturers of air handling units.
- Even more obscure than the commercial data is the usage of the units in practice. There is a wide range of operating practices and product configurations. To combine all these possibilities in one model is almost impossible.

Mainly because of this latter reason, not only a “bottom-up” stock-model approach was used, building on all the inputs from previous Task reports, but also these stock-model data were calibrated and fine-tuned against other sources.

The table below is based on the MEErP 2011 report, Figure 11 which follows a “top-down” approach, splitting Eurostat energy data in ever smaller fractions of end-use. The table below shows an estimate of the space heating fuel for fighting ventilation heat, which concludes to around **1100 TWh (4000 PJ)** of primary space heating energy.

Table 7- 4. Reality check based on MEErP 2011 (Report Part 1, Fig. 11, Data EU-27 - 2007)

	PJ	TWhp	Twhe
Space heating fossil fuel (incl. district heat)	13 225	3 673	
Electric resistance space heaters	1 530	425	170
Chillers	828	230	92
TOTAL	**15 583**	**4 328**	
- of which space heating energy in			
collective residential & non-residential 72%	11 220	3 116	
-- of which space heating fuel for ventilation loss 35% (excl. infiltration)	**3 927**	**1 091**	

The table below is based on the Task 3 report, which builds “bottom-up” the ventilation demand in the collective residential an non-residential sector from the ventilation demand in individual sectors. The table below shows an estimate of the space heating fuel for fighting ventilation heat, which concludes to around **1500 TWh (5400 PJ)** of primary space heating energy, i.e. 36% higher than the top-down approach.

Table 7-5.. Reality check based on Task 3 data (ca. 2007), technical calculation and construction growth rates

	ventilation demand in bln. m^3/h	ventilation heat loss (Twh)*	space heating fuel for fighting ventilation loss (TWh)
1990 (from growth rate 2%/a over 1990-2007)	49	811	1082
2007 (ventilation data from Task 3)	68	1136	**1515**
2025 (from growth rate 1%/a over 2007-2025)	81	1359	1812
2050 (from growth rate 0.5%/a over 2025-2050)	92	1539	2052

**= based on technical calculation : bln.m3/h x 5112h x 9.5K x 0.000344 kWh/m3.K (excl. cooling, see Task 1)*

***= ventilation heat loss at average 75% space heating system efficiency*

As the space heating is fairly up front in the MEErP “top-down” approach, the uncertainties are smaller and the outcome more accurate. Thus, the maximum space heating saving from ventilation can never be more than 1 100 TWh/a in 2007. Using the timeline in the other table, this means a maximum of 1 315 TWh/a in 2025 and 1 500 TWh/a in 2005. In 1990 it was around 800 TWh/a.

The reality checks have prompted a number of corrections in the sales and stock data presented for the baseline in Task 2:

- For CEXH it was assumed that only 25% is actually used for Type C (or B) ventilation of whole buildings, i.e. with a central exhaust duct and grilles in the windows; the rest is considered as simple low-duty extraction fans, e.g. for the toilet groups or wet rooms.
- For the balanced ventilation Base Cases (CHRV and the AHUs) it is assumed that the sales figures in Task 2 are overstated by 20%;
- For the growth rates conservative estimates in the range of 0.5 to 2% were used. The basis for these moderate estimates is given by a variety of parameters listed in the Annex.
- The stock data were calculated in a stock model, assuming the product life of 17 years.

The stock model methodology follows roughly the MEErP 2011 methodology. Main inputs are given in the Annex.

1.6.2 Baseline (BAU)

Based on the above, the following data were used for the baseline sales and stock over the period 1990-1925 with –as an extra dimension—also some rough data for 2030 and 2050.

Table 7- 6. SALES of Energy-related Product (in mln. units/yr)

Category	year-->	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	2030	2050
CEXH		0.168	0.205	0.237	0.262	0.276	0.282	0.290	0.297	0.304	0.304
CHRV		0.000	0.027	0.043	0.070	0.112	0.124	0.137	0.151	0.166	0.203
AHU-S		0.000	0.009	0.014	0.023	0.038	0.041	0.044	0.047	0.051	0.058
AHU-M		0.029	0.033	0.039	0.045	0.052	0.056	0.060	0.065	0.070	0.081
AHU-L		0.032	0.037	0.043	0.049	0.054	0.057	0.060	0.063	0.066	0.073
TOTAL		**0.229**	**0.311**	**0.376**	**0.449**	**0.532**	**0.560**	**0.590**	**0.623**	**0.658**	**0.646**

Table 7- 7. STOCK of Energy-related Product (in mln. units)

Category	year-->	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**2025**	2030	2050
CEXH		2.2	2.4	2.9	3.5	4.3	5.0	5.6	6.1	6.5	7.0
CHRV		0.0	0.2	0.4	0.7	0.9	1.0	1.2	1.3	1.3	1.5
AHU-S		0.0	0.0	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.4
AHU-M		0.3	0.3	0.4	0.5	0.6	0.8	0.9	0.9	1.0	1.1
AHU-L		0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.0	1.1	1.2
TOTAL		**2.8**	**3.3**	**4.4**	**5.5**	**6.7**	**7.9**	**8.8**	**9.6**	**10.2**	**11.0**

As regards the environmental and monetary impacts, the baseline (BAU 'Business-as-usual') is based on a continuation of the current practice in most Northern and some Southern Member States regulations aiming at full heat recovery for AHUs, while other EU Member States are lagging behind. Low-cost exhaust units will continue to hold back market penetration heat recovery units especially for the small-commercial and collective residential sector. Overall, the baseline projection is still quite ambitious and counts on a sales growth rate of heat recovery units at the current pace. The baseline energy savings and the monetary savings are shown in the graphs below.

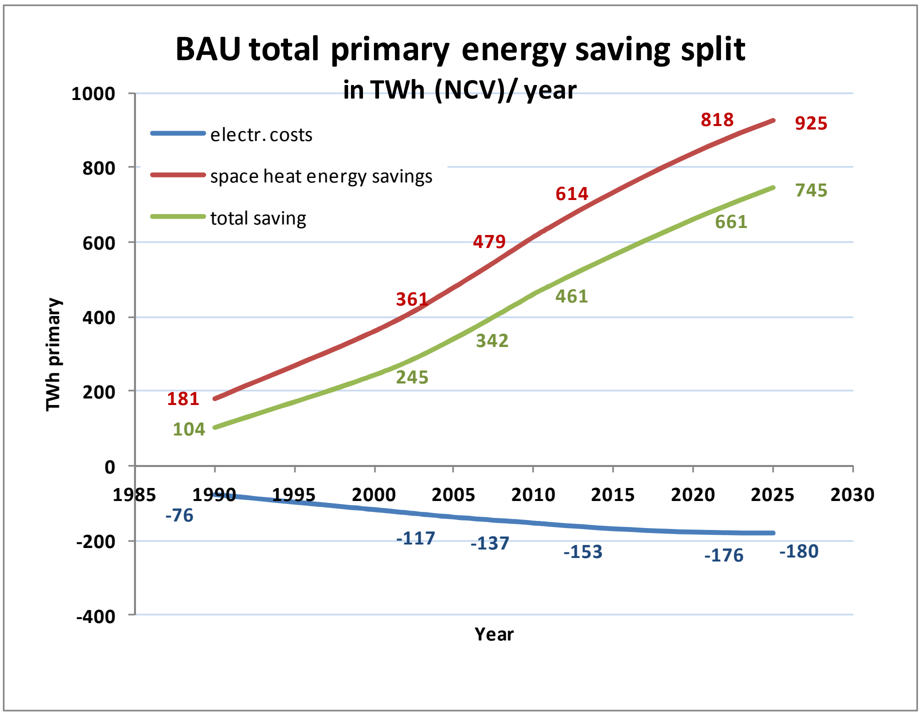

Figure 7- 1. Baseline split of total primary energy saving

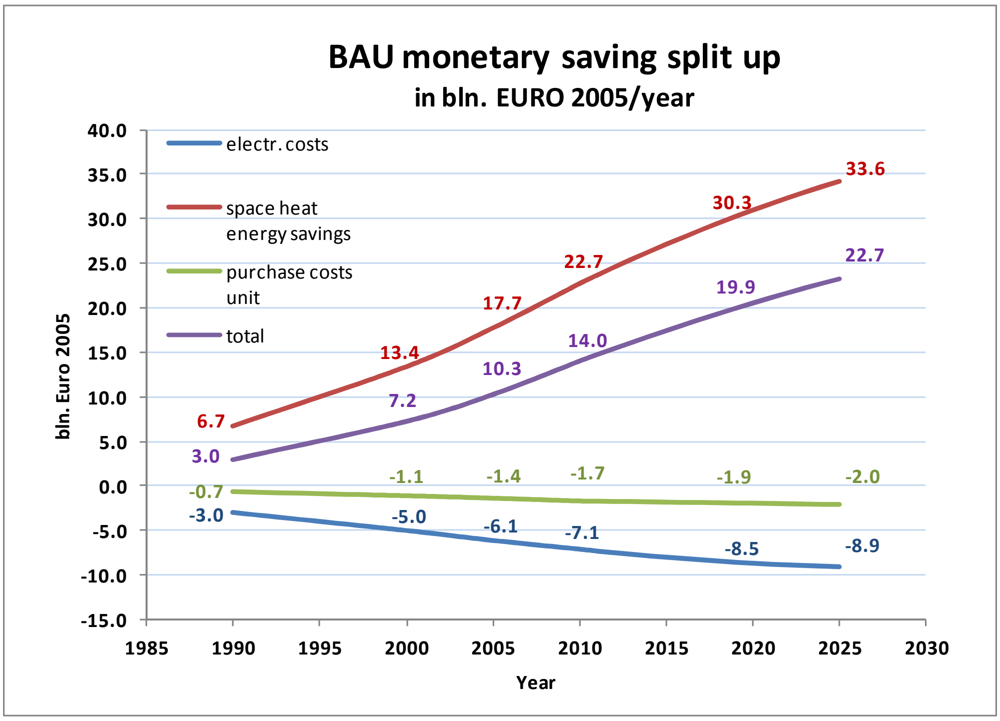

Figure 7- 2. Baseline split of monetary saving

1.6.3 Scenarios

For the policy scenarios the following savings levels were used following Tier 2 requirements (ca. 2016-2017):

- For scenario 1 an improvement of 15% in both electricity and space heating energy saving
- For scenario 2 an improvement of 20% in electricity saving and 40% in space heating energy saving
- For scenario 3 an improvement of 30% in electricity saving and 30% in space heating energy saving

The Tier 1 saving levels (2014-2015) are set at intermediate level: respectively 7.5%, 10 and 20%, 15% respectively.

Scenario 1, based industry expert positions, comes the closest to the baseline. It assumes no savings for exhaust units and a declining CHRV and AHU-S market because of the competition from low-cost exhaust units. Most savings will come from the larger air handling units (AHU-M, AHU-S), where the current practice in some Member States like Germany and Spain of making heat recovery mandatory for these larger units will be made mandatory

Scenario 2, derived from Task 6, is the most ambitious in terms of total energy saving. It aims at best possible space heat energy saving, which is the largest contributor to the overall saving. This will go somewhat at the expense of the saving in electricity, which will be lower because the heat recovery heat exchangers represent extra internal pressure drop.

Scenario 3 is an intermediate scenario. For air handling units it is almost as ambitious as Scenario 2, but it also sets ambitious levels for exhaust units. For CHRVs it assumes that it will be possible to design a legislation that allows certain units to use the domestic ventilation units metrics without a significant negative influence on the overall ambition level of measures.

The details of the stock model methodology are given in the Annex. Although they are approximate they are suited as a first input for the more detailed Impact Assessment that the Commission will probably have to perform, if it decides the product group is eligible for measures and after having presented the Working Documents with draft legislation.

The results of the stock model for the baseline and the 3 scenarios are given in the graphs below. Please note that, in contrast to what is customary, several of the graphs relate not to absolute figures but to savings. E.g. space heating is always expressed as savings versus the reference situation (natural ventilation). The acquisition costs relate only to unit price plus –where appropriate—only the increment/decrement in installation costs. The absolute installation costs (labour and material) are a factor 10 to 20 higher than the unit price, but because they do not contribute to a differentiation between scenarios and their high absolute number would distract from the unit price increments, these absolute costs are not included in the graphs.

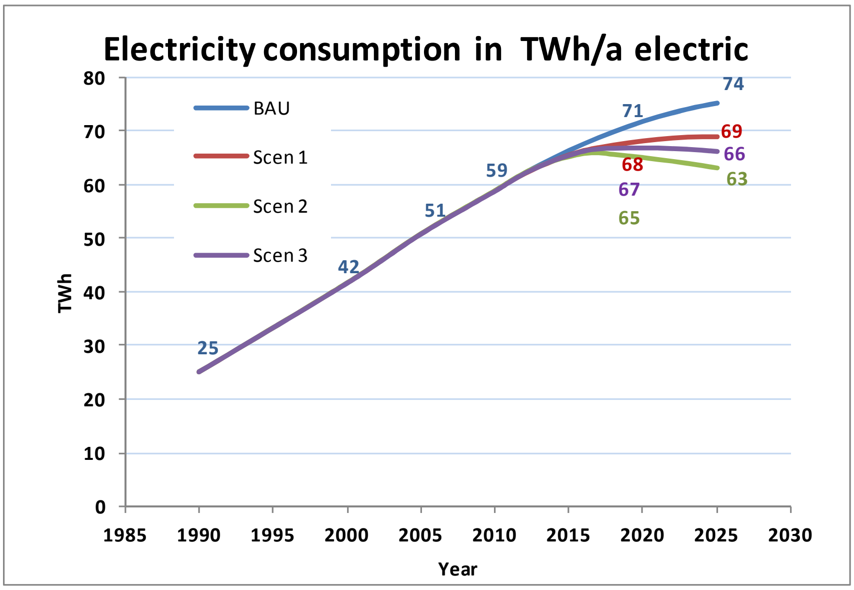

Figure 7- 3. Scenario analysis electricity consumption in TWh/a electric

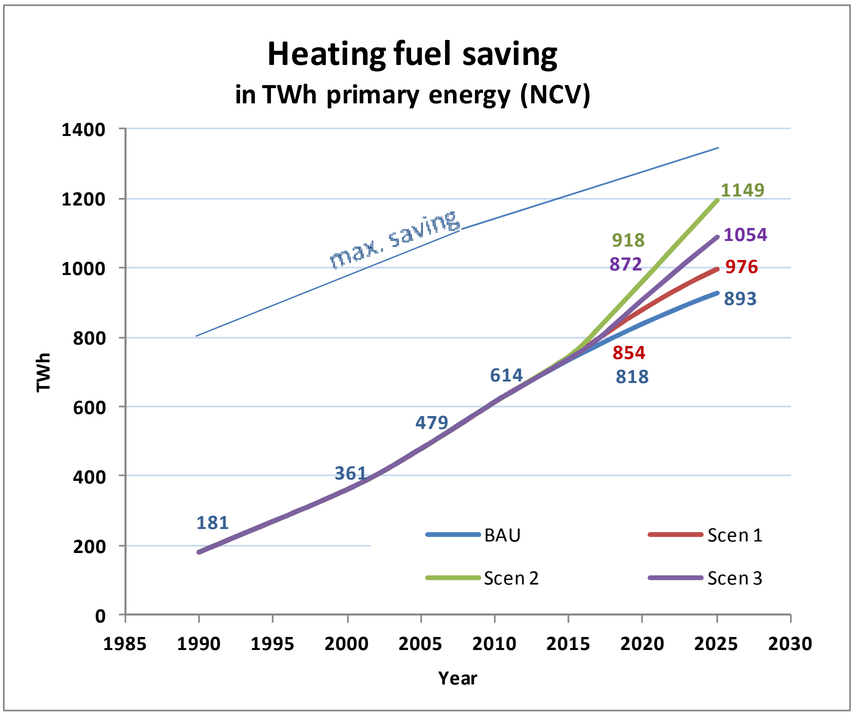

Figure 7- 4. Scenario analysis heating fuel saving in TWh/a primary energy

Figures above show that scenario 2 and probably, at a full stock change which hasn't yet occurred in 2025, scenario 3 will succeed in keeping electricity consumption increase low or zero compared to the 2010 level. The saving versus the baseline in 2025 is 8-11 TWh electric. At the same time the heating fuel saving versus the 2025 baseline is 256 TWh primary energy in Net Calorific Value (NCV) for scenario 2 and 161 TWh for scenario 3.

The "max. saving" line in Figure 7-4 stands for a maximum achievable saving of mechanical ventilation versus natural ventilation.

Compared to the policy reference year of 1990 (e.g. for Kyoto) it is relevant that in 2020 (another policy reference year) the electricity consumption increases by 40-42 TWh electricity and the heating fuel that can be attributed to ventilation losses decreases by 968 TWh primary energy (scenario 2) or 873 TWh (scenario 3).

The figures below show the balance, in TWh primary energy per year, of the energy scenarios and of the very much related greenhouse gas emissions (GHG), expressed in Mt CO2 equivalent per year.

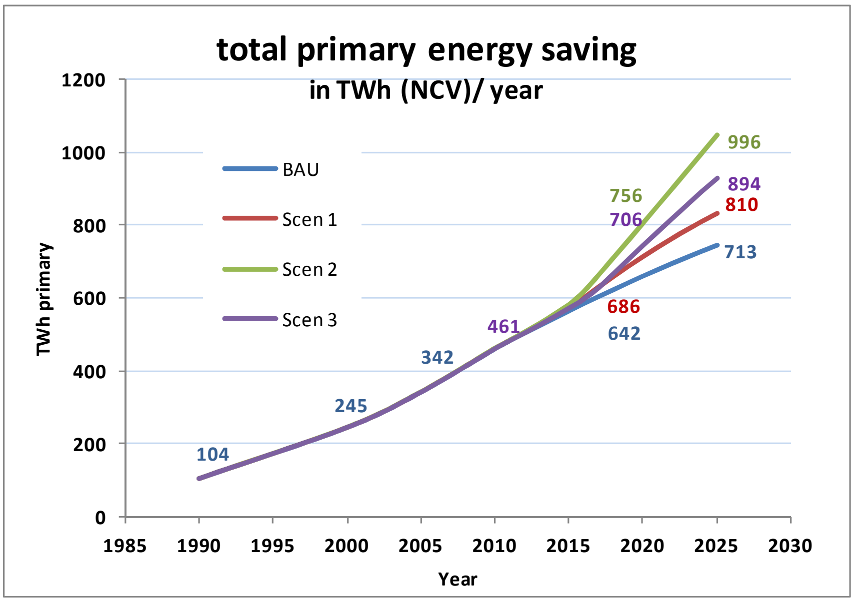

Figure 7- 5. Scenario analysis total primary energy saving in TWh/year primary energy saving (Net Calorific Value NCV)

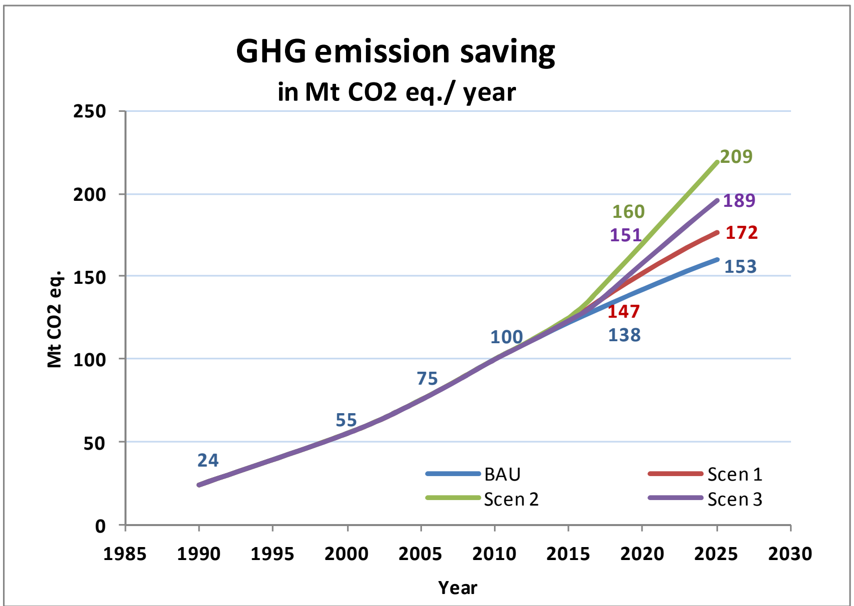

Figure 7- 6. Scenario analysis saving on greenhouse gas emissions in Mt CO2 eq./year

Figure 7-5 shows an overall primary energy saving of 181 (scenario 2) to 283 TWh primary/year (scenario 3) versus the 2025 baseline. Compared to 1990 the 2020 projections show a saving in 2020 of as much as 600-650 TWh primary energy. This is around 2.8 % of the 2007 gross inland consumption in 2007.

The figure show that scenario 3 gives a GHG saving of around 56 Mt CO2 eq. in 2025 versus the baseline. Between 1990 and 2020 the overall GHG-saving is 125 or 134 Mt CO2 for scenarios 2 or 3. This is in the order of magnitude of 2.5% of current EU27 GHG emissions.

For a better understanding of the absolute figures: If tomorrow (2010 data) all mechanical ventilation was eliminated and practice returned to 100% natural ventilation, the EU would use over 460 TWh primary energy (around 40 Mtoe) more and would emit over 100 Mt CO2 eq. of GHG emissions more than today. These figures come close to what 12 million average European citizens consume and emit annually.

2. Impact Analysis

The stock model from the previous chapter was also used to calculate monetary impacts. Detailed quantitative data can be found in the Annex.

2.1 Monetary impacts

2.1.1 User expenditure

The end-user expenditure shows two distinct trends: a period 2013-2020 where the extra investments in acquisition costs exceed the total EU gains from lower energy costs and a period from 2020 onwards where the savings on running costs prevail for the EU as a whole. In total the savings in 2025 are projected to be € 3 bln. (scenario 3) up to € 7 bln. (scenario 2) above the baseline. As mentioned, the stock calculations for 2025 only take into account around a part of the effect of measures because there has not yet been a full stock change in 2025.

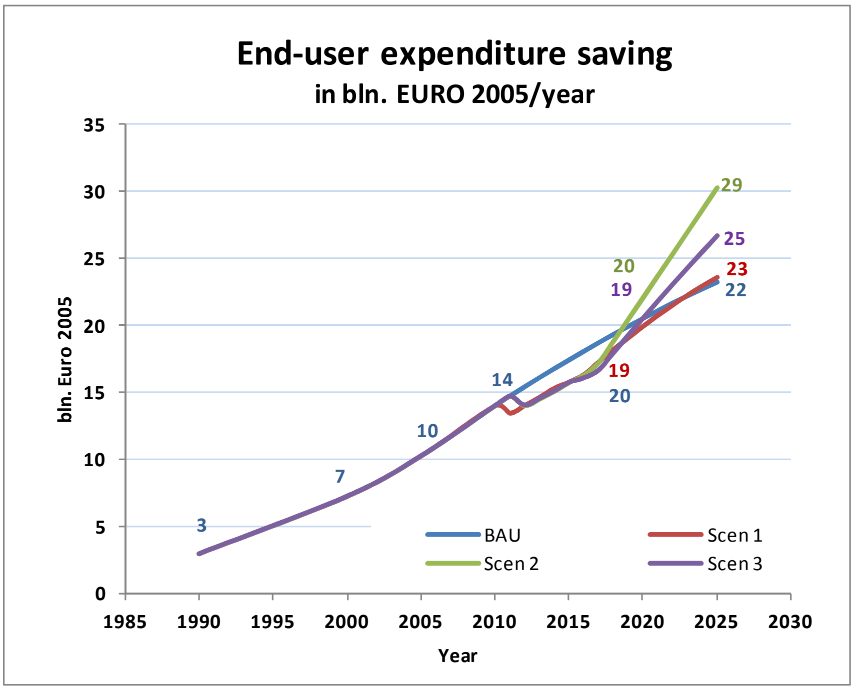

Figure 7- 7. Scenario analysis saving on end-user expenditure in bln. Euro 2005 per year

2.1.2 Sales and Business Revenues

Figure 7-8 gives the outcome of model calculations for the acquisition costs to the end-user of the ventilation units. This means it is based on the projected price increases for the design options from Task 6 for the three scenarios and takes into account a single, realistic construction growth rate (1%/year for 2010-2025).

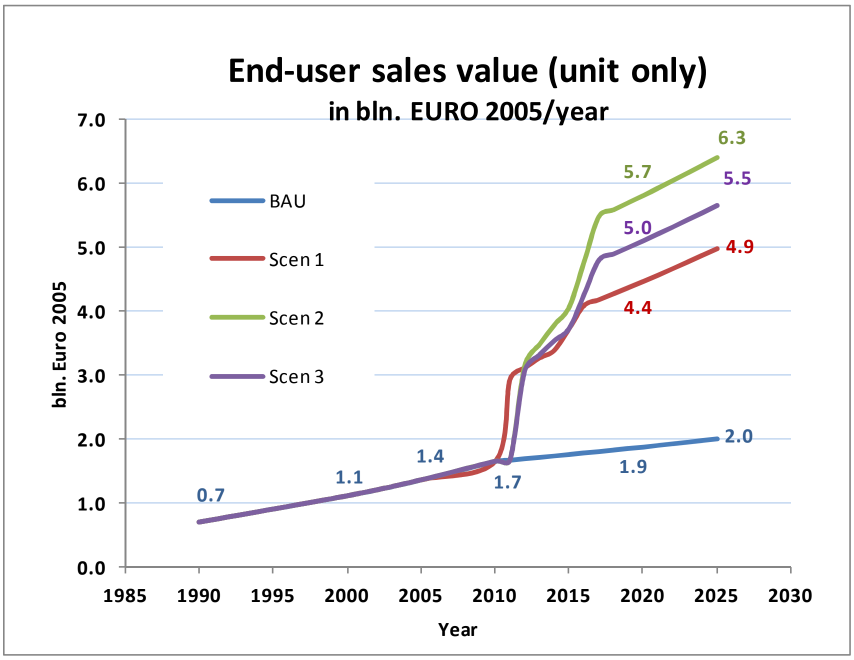

Figure 7- 8. Scenario analysis sales value ventilation units in end-user prices, in bln. Euro 2005 per year

It does not take into account the effects of price decrease through production rationalization and possibly increased competition, nor does it anticipate possible investment delays from clients by putting off acquisition as long as possible and increasing repair efforts. Modelling of these more complex effects are outside the scope of the preparatory study, but they do constitute a warning when interpreting these figures.

What realistically can be foreseen is that the acquisition costs of the ventilation units especially in scenarios 2 and 3 will probably more than double.

For the **builders and their clients** this does not mean that the total costs of the installation will double. Especially with the larger air handling units (AHU-M, AHU,-L) the acquisition costs of the ventilation unit are only a small part (5-10%) of the total system costs. Hence a doubling of the unit price will only translate in a 5-10% of ventilation system acquisition costs.

Also for **the installers**, who often take a margin on the unit and would gain in some cases from the extra ductwork for heat recovery, the doubling of the unit price will not lead to a doubling of the income but perhaps an increase of 20-30%. What will (continue to) lead to an important rise in the installation sector is the continued rise of the number of mechanical ventilation units installed, already in the baseline (BaU).

The market actors that stand most to gain are the **ventilation unit industry and their suppliers** (of fans, heat exchangers, etc.) , where indeed revenues and employment can be expected to more than double, which means close to double-digit growth rates for the sector.

2.2 Qualitative assessments

2.2.1 Competitiveness

The effect on the competitiveness of the industry if the EU becomes a safe-haven for high-quality ventilation products is expected to be very positive for scenarios 2 and 3. Scenario 1 is expected to have a neutral or negative impact in this respect.

High-quality is the continuation of a current trend where already the EU is a net-exporter of quality products in this sector.

As shown in the Task 2 report, exact absolute figures are very hard to come by from official and even industry sources, but what could be retrieved shows that the EU is a net-export of quality products.

Germany, not a country that can be expected to compete on price in the global market, is by far the EU market leader, with –depending on the product/ component— at least a market share of 40-50% in value. Italy is second with around 20% of the market, whereas the remaining 30-40% are divided between the other 25 EU countries. The Czech Republic, apart from Germany, appears to be strong in the supplier side (parts).

The ventilation sector has suffered from the 2009 economic crisis, but far less than some other sectors and already in the second half of 2010 the trend was reversed and has been growing ever since. Balanced units with heat recovery, the ones promoted in the policy scenarios, have become the main driver of the increasing revenues. The exhaust or supply units, based on the little information that is available, appear to be stagnating but also here we see that variable speed units and EC motors –the focus of the policy scenarios-- have become the main stream and only a small minority is still clinging to single speed AC motors.

The first estimates in Task 4 (table 4-16), derived from the Base Cases and based on industry estimates, suggest that the larger ventilation units contribute some € 20 billion to the EU's GDP, in balance between industry revenue of € 2.7 billion, trade/installer revenue of € 37 billion and a negative income effect on the utilities of € 19 billion in 2010.

After the reality check in the underlying task report, these sums may be lower, but the order of magnitude suggests that the ventilation industry has rapidly become a significant sector of the EU-economy over the last 20 years. And the measures suggested will help to streamline the sector also for the next 20 years.

As regards other competitive aspects mentioned in the ToR, such as *market share of products already complying with the envisaged minimum requirement, market shares of remaining models after the minimum requirement is introduced, competitive advantage or negative impacts on the competitive situation of some market players (e.g. SMEs, regional players) or reduction in user choice* the short answer is that this information simply is not available.

The ventilation product sector has only relatively recently begun to get organised as an independent entity in the HVAC sector, which means that market data are very scarce and that there may be large, local differences. Even the estimates that VHK could make in Tasks 2, 4 and 7 for the sector as a whole are very rough, let alone that there would be data on market shares, efficiencies, etc..

Whereas in the Northern part of Europe (Scandinavia, Germany, Netherlands, UK, etc.) the market is well established and, as mentioned in Task 2, driven forward by building regulations and other incentives, the situation in the Southern part of Europe is still difficult to capture.

On one hand, as shown in Task 1, there are countries like Spain and Portugal where heat recovery ventilation has been 'discovered' in building legislation as being relevant to a building's energy efficiency even in those climate zones (i.e. also for space cooling). In countries like Italy, Greece and Cyprus –where it could be equally useful—it is still largely 'terra incognita', despite the fact that e.g. Italy would have the industry to be a major player in that product field. How this will play out, especially in the short run, is uncertain also given the current financial crisis (2012) forcing governments to be very careful in providing incentives from tax money.

2.2.2 Social impacts

Based on an average revenue of € 0.16 million/industry job and € 0.1 million per installer, figures that are customary in the HVAC sector, it can be estimated that current industry employment will be around 15.000 jobs, whereas the employment in the installation sector –for more than 80% SMEs—is between 300 and 400.000 jobs.

Already in a baseline scenario the installer jobs will grow with at least 50%; the policy measures will add on to that and an employment of around 200 000 extra jobs can be expected in the installation sector. The industry sector is expected to profit even more from the policy measures and –due to the baseline trend plus the measures— the employment with manufacturers is at least expected to double over the next decade to 30-40 000 jobs (15 -20 000 extra jobs).

Having said that, these optimistic forward looking statements should be accompanied by a big warning. As mentioned in the previous paragraph, the ventilation industry as an independent sector is still young, which means that industry data are poor and that useful specific data from official sources such as Eurostat are almost non-existing. And, again, the local differences may be large.

2.2.3 Proprietary technology and administrative burden

The proposed policy measures, promoting fan & motor efficiency as well as heat recovery, do not force manufacturers in fields of proprietary technology. The technologies mentioned are currently undergoing an evolutionary development to which any industry with enough know-how could enter. See also Task 5 and 6. In this respect all scenarios are equal.

Also in terms of administrative burden all scenarios are more or less equal. Most part of the product information requirements are already customary today.

2.2.4 Functionality

As has been explained in Task 3, the application of better controls, more efficient fans & motors and especially more and better heat recovery, does not impair the functionality of the product but significantly improves it when installed and maintained properly. In this respect scenario 1 has a neutral or negative impact and scenarios 2 an 3 a positive impact.

2.2.5 Innovation

In Tasks 5 and 6 it has been mentioned that innovation in the sector as regards electric efficiency and heat recovery efficiency will be evolutionary. Heat exchangers with a heat recovery efficiency with over 90% exist, DC motors of 100 kW –currently applied in electric cars—exist, aerodynamically optimised impellers and casings exist, the most sophisticated ventilation control technology exists, even and it is ‘just’ a matter of putting in the time, effort, know-how, investment and courage before all these things will be applied in ventilation units or rather ventilation systems (including the ductwork) leading to evolutionary improvements in the order of magnitude of 10-20%.

However, ‘evolutionary’ does not mean that these things happen spontaneously without a driving force. The Ecodesign measures as proposed in scenarios 2 and 3, strong and with a clear focus, are an important factor in diminishing the risks of investing in new technology. Alternatively, wavering and weak measures, still leaving room for cheap single speed AC motor driven fans like proposed in scenario 1 or balanced ventilation units without heat recovery would be highly detrimental for innovation. Potentially innovative manufacturers would renounce to make the necessary investments in R&D, tooling, marketing, installer training, etc. and just prepare for a price-war which the EU industry can never win.

A second aspect of innovation and Ecodesign lies not in the efficiency improvement of the product itself, but in its wider diffusion. As indicated in Task 3, only 7% of the non-residential and collectively residential buildings in the EU use heat recovery ventilation.

This means that, 93% of building ventilation uses either a suboptimal mechanical ventilation system or no system at all ! In other words, in the EU there are over 12 million collective residential buildings, 4 million tertiary sector buildings and over 2 million industrial buildings with a substantial improvement potential.

New building construction will do very little to increase that figure. The challenge will be, and this is very much a field also of technical innovation, to find ‘ventilation solutions’ for renovation and retrofit in existing buildings that were never conceived to hold heat recovery, demand-side controlled ventilation. Industry will have to be working even more closely with planners and builders, juggling between what is best and what is feasible, using hybrid configurations of big and small systems, heat recovery and smart demand-side controlled extraction ventilation all working together.

2.2.6 Summary table qualitative impacts

Table 7- 8. Rating Qualitative Impacts

BOUNDARY CONDITIONS ("should be no negative impacts")	**Scenarios 2020/ 2025**		
	1	**2**	**3**
"No negative impacts" following Art. 15, sub 5 of 2009/125/EC	less ambitious	most ambitious (LLCC)	intermediate
functionality of product	0/-	+	+
health, safety and environment	0/-	++	++
affordability and life cycle costs	0/+	+	+
industry competitiveness	0/-	+	+
no proprietary technology	+	+	+
no excessive administrative burden	+	+	+

Key: ++ = Strong Positive Rating + = Positive Rating 0 = Neutral Rating - = Negative Rating.

2.3 Conclusion

The final stakeholder meeting of 16 april 2012 and the written comments afterwards, or rather the lack of comments of a principal nature, indicate that there is a fair amount of consensus on the principles and ambition level for Ecodesign measures and thus a robust basis for the Commission to start drafting Working Documents and prepare Impact Assessments.

It does not mean that all problems, especially those of a technical nature, are solved but even in the case of the dispute between SFP and EN 13053 the positions of industry groups are close together.

During the preparations in the next stage the Commission, in consultation with the stakeholders, will have to make final decisions on these issues.

For the moment, it appears that the saving potentials mentioned in Scenario 2, with possibly some minor modifications leaning more towards Scenario 3, are realistic.

Table 7-9. Summary of projected annual savings Scenario 2 (Scenario 3 in brackets) versus Business-as-Usual BaU, in 2010, 2020, 2025

	2010	2020		2025	
Electricity consumption in Twh$_{el}$/a					
BaU	59	71		74	
Scenario 2 (3)		65	(67)	63	(66)
Saving		6	(4)	11	(8)
Heating fuel saving in Twh$_{prim}$/a					
BaU	614	818		893	
Scenario 2 (3)		918	(872)	1194	(1054)
Extra saving		100	(54)	301	(161)
Total primary energy saving in Twh$_{prim}$/a					
BaU	461	642		713	
Scenario 2 (3)		756	(706)	996	(894)
Extra saving in Twhprim/a		114	(64)	283	(181)
Extra saving in PJ/a		*410*	*(230)*	*1019*	*(652)*
Total GHG savings in Mt CO_2/a					
BaU	100	138		153	
Scenario 2 (3)		160	(151)	209	(189)
Extra saving		22	(13)	56	(36)
Total end-user expenditure savings in billion (10^9) Euro/a					
BaU	14	19		22	
Scenario 2 (3)		20	(19)	29	(25)
Extra saving		1	(0)	7	(3)

All savings are calculated against reference natural ventilation

Conversion: 1 TWhel = 2.5 TWhprim; 1 TWhprim = 3.6 PJ

Roughly half of the savings on electricity consumption can be attributed to measures under the Ecodesign Fan Regulation 327/2011. This means that in 2025 around 900-950 PJ/a primary energy extra saving, comparable to around 100 TWh electricity consumption per year, and around 50 Mt CO2 saving can be attributed to the specific proposed measures.[20] The total saving in end-user spending that can be attributed to the proposed measures is projected to be over € 6.5/a billion in 2025.

[20] estimated 5-10 TWh electric, see Task 6 report

List of Tables

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References

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Annex I. Stock model

Main inputs

The main inputs for the stock model, apart from the ones already given in the main report, are

elast	**56**	Euro purchase price increase (2010)/% efficiency increase (versus BaseCase) untill llcc
elastbat	**119**	Euro purchase price inc. (2010)/% efficiency increase (versus LLCC) beyond llcc
Plife	**17**	Product life in years
Growth rate <2000	**2%**	annual growth rate sales 1990-2000
Growth rate 2000-'20	**1%**	annual growth rate sales 2000-2020
Growth rate <2020	**0.50%**	annual growth rate sales 2020-2050
Rel1	**0.12**	Electricity rate 1.1.2011 [€/ kWh electric] , weighted average small, medium , large users
Rgas1	**0.037**	Gas rate 1.1.2011 [€/kWh GCV], incl. VAT, weighted average small, medium , large users
Relinc	**6%**	Annual price increase electricity [%/ a]
Rgasinc	**6%**	Annual price increase gas [%/ a]
Inflation	**2.50%**	Inflation rate [%/ a]
Interest	**6.50%**	Interest rate [%/a]
Discount	**4%**	The discount rate is expressed in real terms, taking account of inflation. This rate of 4%, used in the Commission's impact assessments, broadly corresponds to the average real yield on longer-term government debt in the EU over a period since the early 1980s. For impacts occurring more than 30 years in the future, the use of a declining discount rate could be used for sensitivity analysis, if this can be justified in the particular context

Power gen. & distr. Fixed	40%	Electric power generation & distribution efficiency						
		1960	**1990**		**2010**	**2018**	**2030**	**2050**
Power gen. & distr. dynamic, in %	kg/kWh elec.	30%	33%		38,50%	40%	43%	47%
		1960	**1990**	**2000**	**2010**	**2020**	**2030**	**2050**
GWP electric, in Mt/TWh (=kg/kWh)	kg/kWh elec.	0,55	0,5	0,43	0,41	0,38	0,34	0,28
GWPgas	0,202	Mt CO2 eq./TWh NCV						
GWPoil	0,267	Mt CO2 eq./TWh NCV (gas/diesel oil)						
GWPlpg	0,227	Mt CO2 eq./TWh NCV						
		1960	**1990**	**2000**	**2010**	**2020**	**2030**	**2050**
oil share (% of CH stock)	kg/kWh elec.	30%	18%	14%	10%	6%	2%	0%
lpg share (% of CH stock)		0%	4%	4%	4%	4%	4%	4%
gas share (rest % of stock)		70%	78%	82%	86%	90%	94%	96%
aggregate GWPfossil (CH)		0,2215	0,2147	0,2121	0,2095	0,2069	0,2043	0,203

Growth rates

The baseline scenario growth rates are based on the following:

Growth indicators stock model

GDP 2010 (bln. Euro, current prices)	**12256**
Annual Growth '95-'10 (in current prices)	3.8%
Annual Growth '10-'13 (in current prices)	3.0%
GDP in 2005 prices (inflation and exchange rate corrected)	
GDP 2010 (bln. Euro 2005)	**11555**
GDP 2005 (bln. Euro 2005)	11060
Annual Growth '95-'10	1.9%
Annual Growth '10-'13	1.2%
Index 2010 (2005=100)	106.1
Purchasing Power Standard PPS 2010 (000 Euro/inhabitant)	**24.4**
Annual growth 1995-2010	3.4%
Final expenditure 2010 (in bln. Euro 2005)	**9211**
growth rate 2004-2010	1.2%
growth rate 2010-2013	0.4%
Household & NPISH final consumption expenditure (bln. Euro 2010)	**6699**
growth rate 2004-2010	1.0%
growth rate 2010-2013	0.5%
Households number, 2010 (in mln.)	**197**
househ. annual growth rate <=1990	1.20%
househ. annual growth 1990-2010*	0,26%+0,028%*(2010-Year)
househ. annual growth rate >2010*	0.25%
*= multiplier before 2010 is 1/(1+x) ; after 2010 is (1+x)	
Population number of inhabitants 2010 (in mln.)	**501.1**
pop. annual growth rate <=2010	0,2%+0,009%*(2010-Year)
pop. annual growth rate >2010	0,2%-0,003%*(Year-2010)
Dwellings	
avg. dwelling surface 2010 in m2	89.91
m2 surface/dwelling growth rate	0.35%

<u>number of dwellings</u>=1,25*households (80% of dwelling stock is conventional, permanent use; rest is 2nd home, vacant, unconventional, etc.)
<u>demolished</u> no. of dwellings = ca. 10% of new built dwellings
"household" (building statistics) is individuals sharing 1 primary dwelling
"family" (building statistics) = marriage or similar
"housing shortage" = new built - demolished - families - divorces

Detailed tables

PARAMETER	unit	1990	1995	2000	2005	2010	2015	2020	2025
Sales	mln.# /a	0.2	0.3	0.4	0.4	0.5	0.6	0.6	0.6
Stock	mln.# /a	2.8	3.5	4.4	5.5	6.7	7.9	8.8	9.6
load (demand) ELEC	perform/unit.a	16.4	17.3	18.0	18.0	17.3	17.3	17.3	17.3
load (demand) GAS	perform/unit.a	9.6	10.1	10.5	10.5	10.1	10.1	10.1	10.1
ref. Elec. energy/perform(=100%)*	kWh/perform	422.5	432.9	438.4	451.0	467.8	472.4	477.1	481.7
ref. Gas energy/perform(=100%)*	kWh/perform	6508.1	7466.7	7808.1	8351.1	9103.1	9254.5	9407.5	9562.0

***=explain the principle used**

ELEC consumption EU in TWh electric/year		1990	1995	2000	2005	2010	2015	2020	2025
BAU	TWh elec/yr	25	33	42	51	59	66	72	75
Scen 1		25	33	42	51	59	66	68	69
Scen 2		25	33	42	51	59	65	65	63
Scen 3		25	33	42	51	59	66	67	66

GAS consumption EU in TWh primary/year		1990	1995	2000	2005	2010	2015	2020	2025
BAU	TWh prim/yr	181	265	361	479	614	733	838	925
Scen 1		181	265	361	479	614	740	881	996
Scen 2		181	265	361	479	614	746	964	1195
Scen 3		181	265	361	479	614	739	910	1088

efficiency elec. gen.&distr. dynamic	33%	34.4%	35.8%	37.1%	38.50%	39.4%	40.5%	41.8%

Primary ENERGY saving EU in TWh primary/year		1990	1995	2000	2005	2010	2015	2020	2025
BAU	PJ/yr	104	171	245	342	461	565	661	745
Scen 1		104	171	245	342	461	574	712	831
Scen 2		104	171	245	342	461	581	804	1044
Scen 3		104	171	245	342	461	573	745	930

MtCO2/TWh el.	0.500	0.465	0.430	0.420	0.410	0.395	0.380	0.360
MtCO2/MJ fossil (only if it is a mix)	0.215	0.213	0.212	0.211	0.210	0.208	0.207	0.206

GHG emission savings EU in Mt CO2 eq./year		1990	1995	2000	2005	2010	2015	2020	2025
BAU	MtCO2/yr	23.9	38.4	55.0	75.4	99.9	121.9	142.0	159.8
Scen 1		23.9	38.4	55.0	75.4	99.9	123.6	152.0	176.4
Scen 2		23.9	38.4	55.0	75.4	99.9	125.0	170.1	218.8
Scen 3		23.9	38.4	55.0	75.4	99.9	123.4	158.4	196.0

Energy Costs saving in bln. EUR/year		1990	1995	2000	2005	2010	2015	2020	2025
BAU	bln. Eur/yr	3.7	5.9	8.4	11.6	15.7	19.2	22.4	25.2
Scen 1		3.7	5.9	8.4	11.6	15.7	19.5	24.4	28.6
Scen 2		3.7	5.9	8.4	11.6	15.7	19.8	27.9	36.7
Scen 3		3.7	5.9	8.4	11.6	15.7	19.5	25.6	32.3

Acquisition costs (Eur/unit), incl. up-front EoL costs (recupel levy) ELEC		1990	1995	2000	2005	2010	2015	2020	2025
BAU	Eur/unit	3066	2963	2961	3036	3112	3151	3190	3227
Scen 1		3066	2963	2961	3036	3112	6672	7575	8007
Scen 2		3066	2963	2961	3036	3112	7267	9848	10291
Scen 3		3066	2963	2961	3036	3112	6672	8652	9089

Acquisition costs (Eur/total sales), incl. up-front EoL costs (recupel levy) TOTAL		1990	1995	2000	2005	2010	2015	2020	2025
BAU	bln. EUR	0.7	0.9	1.1	1.4	1.7	1.8	1.9	2.0
Scen 1		0.7	0.9	1.1	1.4	1.7	3.7	4.5	5.0
Scen 2		0.7	0.9	1.1	1.4	1.7	4.1	5.8	6.4
Scen 3		0.7	0.9	1.1	1.4	1.7	3.7	5.1	5.7

Total EU-27 saving on consumer expenditure		1990	1995	2000	2005	2010	2015	2020	2025
BAU	bln. Eur/yr	3.0	5.0	7.2	10.3	14.0	17.4	20.5	23.2
Scen 1		3.0	5.0	7.2	10.3	14.0	15.8	19.9	23.6
Scen 2		3.0	5.0	7.2	10.3	14.0	15.7	22.1	30.3
Scen 3		3.0	5.0	7.2	10.3	14.0	15.7	20.5	26.7

Total sales value consumer prices (bln. Eur)	Product price incl. VAT excl. Install	1990	1995	2000	2005	2010	2015	2020	2025
BAU	bln. EURO	0.7	0.9	1.1	1.4	1.7	1.8	1.9	2.0
Scen 1		0.7	0.9	1.1	1.4	1.7	3.7	4.5	5.0
Scen 2		0.7	0.9	1.1	1.4	1.7	4.1	5.8	6.4
Scen 3		0.7	0.9	1.1	1.4	1.7	3.7	5.1	5.7

Annex II. Product Information Requirements, example

Ventilation units with individual fan power >125 W:

1. Maximum air flow [in m³/h][21]
2. Maximum external static pressure [in Pa][22]

3. Rated ('design', 'nominal') air flow q_v [in m³/h]
4. External static pressure at rated air flow Δp_{stat} [in Pa]
5. Measured electric power consumption of the ventilation unit at rated airflow [in W, according to EN 13053/A1:2010]

6. Fan type [axial/ forward curved or radial/ backward curved with or without housing/ mixed flow/ cross-flow; all individual fan related data according to EC Regulation No. 327/2011[23]]
7. Fan overall efficiency (η), rounded to 1 decimal place;
8. Fan measurement category used to determine the energy efficiency (A-D);
9. Fan efficiency category (static or total);
10. Fan efficiency grade (N) at optimum energy efficiency point;
11. Whether the calculation of fan efficiency assumed use of a VSD and if so, whether the VSD is integrated within the fan or the VSD must be installed with the fan ['VSD prescribed' or 'VSD integrated', from fan-OEM];
12. Rated fan motor power input(s) (kW), flow rate(s) and pressure(s) at optimum energy efficiency;
13. Fan rotations per minute at the optimum energy efficiency point ;
14. Fan 'specific ratio'[24];

15. Flow Rate Variation FRV class [FRV class (fixed/multiple preset/ variable, according to prEN 13141-8: 2011]
16. Variable speed drive range: minimum and maximum [in % of maximum air flow];
17. Variable speed drive, number of speed steps with % of maximum air flow or 'continuous' (>10 steps);

[21] Legally significant. Minimum equals rated air flow and maximum equals theoretical air flow at 0 Pa pressure, always at maximum fan speed. Rated air flow, in balanced systems referring to supply air, shall not be lower than 65% of declared maximum air flow. Manufacturers shall declare clearly in their technical documentation and contracts that they assume no liability whatsoever if the unit is operated at air flow rate higher than the declared maximum. If not indicated otherwise, all values in this annex are rounded to whole numbers.

[22] As ibid 1. Minimum equals rated external pressure and maximum equals theoretical external pressure at 0 m³/h air flow, always at maximum fan speed. Rated pressure shall not be lower than 65% of the maximum external pressure. An alternative test and calculation method may be applied only if the maximum pressure does not exceed 100 Pa. Also here the liability clause applies.

[23] L 90/16 Official Journal of the European Union 6.4.2011

[24] the stagnation pressure measured at the fan outlet divided by the stagnation pressure at the fan inlet at the optimal energy efficiency point of the fan (cit. EC Regulation No. 327/2011)

18. Flow Rate Control FRC class, if applicable [FRC class according to prEN 13141-8: 2011[25]]

19. Reference electric power consumption at q_v and Δp_{stat} [0.85*Pm_{ref} , in W, according to EN 13053/A1:2010][26];

20. Thermal efficiency η_t of heat recovery system [according to EN 308:1997 and EN 13053/A1:2010]
21. Sum of pressure drops over supply and exhaust side Δp_{HRS} of heat recovery system at rated conditions [in Pa, according to EN 308:1997] ;
22. Auxiliary electricity consumption for heat recovery system (possibly pump, rotor-motor, condensate-pump..) $P_{el\ aux}$ [in W];
23. Electricity consumption attributed to pressure loss of the heat recovery system P_{el} [in W, according to EN 13053/A1:2010];
24. Energy efficiency η_e of heat recovery system [according to EN 13053/A1:2010];
25. Corrections applied to heat recovery energy efficiency η_e for unbalance and/or humidity ratio [none/unbalance/humidity/both; relates to correction formulas in EN 15305/A1:2010];[27]
26. Flow Balance Control class [FBC 1..4, none/manual/fan rpm control/dynamic, according to prEN 13141-8: 2012]
27. Bypass Options BPO class [BPO 1..4, no bypass/on or off/partly/variable, according to prEN 13141-8: 2012]
28. Bypass Flow rate Control BFC class [BFC 1..5, none/manual/ time controlled/ temperature controlled/humidity controlled]
29. Type of Frost Protection TFP class [TFP 1..7, none/electric preheat/mixing air/ lower supply air flow/ increase exhaust air flow/ bypass for defrosting/ not classified]

30. Effective front filter surface or –for units without filter module— front surface of smallest casing free casing section in m² with 2 digit precision;
31. Face velocity at above location [in m/s with 1 digit precision, according to EN 13053/A1:2010];

32. Ventilation unit equipped for mounting filters [no, yes: at supply side/ at exhaust side/ both at supply and exhaust side];
33. Supply filter class ['not applicable' or G1..G4, M5..M6, F7..F9, etc.[28]];
34. Supply filter pressure drop and energy efficiency class [pressure in Pa and energy efficiency class A..G, according to Eurovent regulation 4/11 and EN 779:2012 referenced therein, if applicable];
35. Exhaust filter efficacy class ['not applicable', G1..G4, M5..M6, F7…F9, etc.];
36. Exhaust filter pressure drop [in Pa, according to Eurovent regulation 4/11 and EN 779:2012 referenced therein, if applicable];
37. Filter section(s) equipped with measuring devices for filter pressure drop and Filter Indicator Type FIT class [yes/no; FIT 1..4: time/ pressure/ optical/ air volume controlled];

[25] This standard (date May 2011) reflects the latest developments in standardisation work on control types for ventilation units (see Table 1-18 in Task 1 report). FRC class definition builds on EN 13799:2007. Declaration is mandatory for single fan units; for balanced units it only applies when part of the product placed on the market (otherwise fill in 'non applicable').
[26] Value serves as compliance check for the parameter below
[27] Relevant for compliance check by surveillance authorities
[28] Currently according to EN 779:2002 but the new EN 779:2012 is ratified and should be used as a reference in legislation. The main changes are the introduction of medium filter classes (M5 and M6 replacing F5 and F6) and the addition of new requirements on minimum filtration efficiency (ME) for fine air filters (F7, F8 and F9).

38. Signalling of filter pressure drop exceeding maximum standard final pressure drop [yes/no, signalling method[29], standard final pressure drop values according to EN13053:2007];
39. Filter by-pass leakage [calculation and method to be determined, e.g. from EN 1886:2007, EN308:1997 and/or tracer gas method, possibly FBL classification according to prEN 13141-8:2012];
40. Filter(s) delivered with the unit or –if no filter is supplied—filter(s) used for compliance assessment, if applicable [manufacturer, model];

41. External leakage [indicative limit 10%, calculation and method to be discussed, e.g. from EN 1886:2007, EN308:1997 and/or a comparable tracer gas method];
42. Internal leakage between supply and exhaust side in heat recovery system [as above]
43. Recirculation flow, if applicable[30] [as above];

44. Specific fan power SFP in kW/m²/s [according to EN 13799:2007];
45. Specific fan power class [SFP1…SFP7, according to EN 13799:2007];
46. Eurovent certification scheme class [A…E, according to Eurovent Reglementation];
47. RLT certification scheme class [A+…B, according to RLT];

48. Information relevant for proper dimensioning of the ventilation unit [to be discussed: possibly reviewed Table B. 2 from EN 15251[31] with recommendations and calculation values regarding air infiltration, duct leakage, etc., see (reaction to) comments from REHVA TRC-chair and UBA comments];
49. Information relevant for facilitating disassembly, recycling or disposal at end-of-life[32];
50. Information relevant to minimise impact on the environment and ensure optimal life expectancy as regards installation, use and maintenance of the fan[33];
51. Description of additional items used when determining the fan energy efficiency, such as ducts, that are not described in the measurement category and not supplied with the fan.[34]
52. If possible: Information relevant to expected energy savings of the unit per climate zone (Average, Warmer, Colder; suitable format to be discussed)

The exact wording used in the list does not need to be repeated. If items on the list are not applicable they may be omitted.

Note that the direct reference to EN standards is not admitted in Commission Regulations for legal reasons[35]. Hence in the Working Documents (draft legislation) the Commission will have to

[29] Description, e.g. through blinking alarm on control interface, signal light/LED on casing, etc.

[30] Recirculation requirement is applicable only if rigid in- and outlet duct configuration is part of the product placed on the market. Not applicable if in- and outlet components are not part of the product or should be connected separately through ducts and positioned taking into account the minimum distance between in- and outlet as indicated in EN 13779 and/or national building legislation.

[31] See Task 1 report, Table 1-23.

[32] Includes but is not limited to product information requirement sub(12) of EC Regulation No. 327/2011/EC.

[33] Includes but is not limited to product information requirement sub(13) of EC Regulation No. 327/2011/EC.

[34] Includes but is not limited to product information requirement sub(12) of EC Regulation No. 327/2011/EC.

formulate the most important parts of the standards mentioned and a transitional method, in the form of a Commission Communication, will have to ensure that effectively the standards and other documents cited are followed. This work is not part of the preparatory study contract.

[35] An approved regulation (as opposed to a Directive, which has also a national adoption procedure) is immediately European law and therefore all stipulations and references should be available in all EU languages, which is not the case with EN standards (only 3 languages). Furthermore, stipulations from the WTO-treaty apply.