Ventilation Systems, ENTR Lot 6, Tasks 1-5

Executive summary

Introduction

This is the draft report for tasks 1-5 on 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'.**

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 report on ventilation systems is VHK.

Scope

The products covered in this study are mechanical ventilation units with an electric power input per individual fan larger than 125 W. Their primary function is to exchange –wholly or partly by mechanical means-- polluted indoor air in a building with relatively clean outdoor air, in order to achieve a healthy level of Indoor Air Quality (IAQ) for the building's inhabitants and construction. The mechanical ventilation can be achieved by

- a single-fan *'exhaust'* unit, 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[1], or
- a double-fan *'balanced'* unit , providing both the air exhaust and air supply mechanically.

The 'balanced' units can be subdivided in *air handling units* (AHUs) and *central heat recovery ventilation units* (CHRV). The former are balanced units that are pre-disposed to also contain a section with one or two cooling and/or heating heat exchanger (a.k.a. 'coils'). The latter are balanced units dedicated to heat recovery ventilation only.

Mechanical ventilation units with individual fan power of 125 W or lower are not in the scope of this study. They are treated in a separate Ecodesign study on Domestic Ventilation [DG ENER lot 10]. Technical ventilation (e.g. mining, hospital operating rooms, high-temperature applications) is also not included in the scope of this preparatory study.

The products in the scope of the study are relatively large, given the lower limit of 125 W, and thus are used predominantly in *non-domestic or collective domestic applications*. Two-thirds of commercial buildings and half of the public administration buildings rely on mechanical ventilation, which has become indispensable in any modern, air-tight and thus energy-efficient building.

The units are usually *centralized*, meaning that they serve several individual rooms/zones of the building through a *ductwork with silencers, dividers and terminal units*. The ductwork and related components are not in the product scope of the study.

[1] A.k.a. "rooftop fans" / "boxed fans" / exhaust ventilation units are incorporated in LOT 11 preparatory study but not part of measures individual fans.

The interaction between ventilation and airconditioning systems is limited. Most of the space cooling (and air heating) in today's modern buildings is taken care of by water-based systems ('*chillers*' and '*fan coil units*') or refrigerant-based products.

The AHUs provide pre-cooling of the ventilation air and thus take care of only a relatively small part of the cooling load. The energy for pre-cooling (pre-heating) does not come from the AHU itself, but is provided by an external source, such as a chiller (boiler). Pre-cooling and pre-heating energy consumption thus appears in the energy balance of heating and cooling products in the Air Conditioning part of the ENTR Lot 6 study and in the ENER Lot 1 (CH boilers) and Lot 21 (air heating) preparatory studies. The energy use of the AHU attribuable to the pre-cooling or pre-heating function comes from the extra pressure drop over the heat exhanger (the 'coil') that makes the fan motor work a little harder.

The energy efficiency of individual fans (incl. motor & drive), inside a ventilation unit will be part of Ecodesign measure for 'fans' in the power range above 125W following ENER Lot 11. The assessment of the electricity consumption of a fan integrated in a ventilation unit adds several important dimensions, relating to e.g. internal pressure drop of the components, effectiveness in responding to ventilation demand and optimisation of controls in general.

In an exhaust unit, consisting of casing, fan and fan controller and possibly one or more sensors, the aerodynamic design, the fan's operating mode (e.g. fan speed) and the intelligence of the controller have a significant impact. In a balanced unit, shown below, also the pressure drop of individual components like filters, heat recovery unit and coils are major contributors to the electricity use of the ventilation unit. Humidifiers and dehumidifiers are not covered by the product scope.

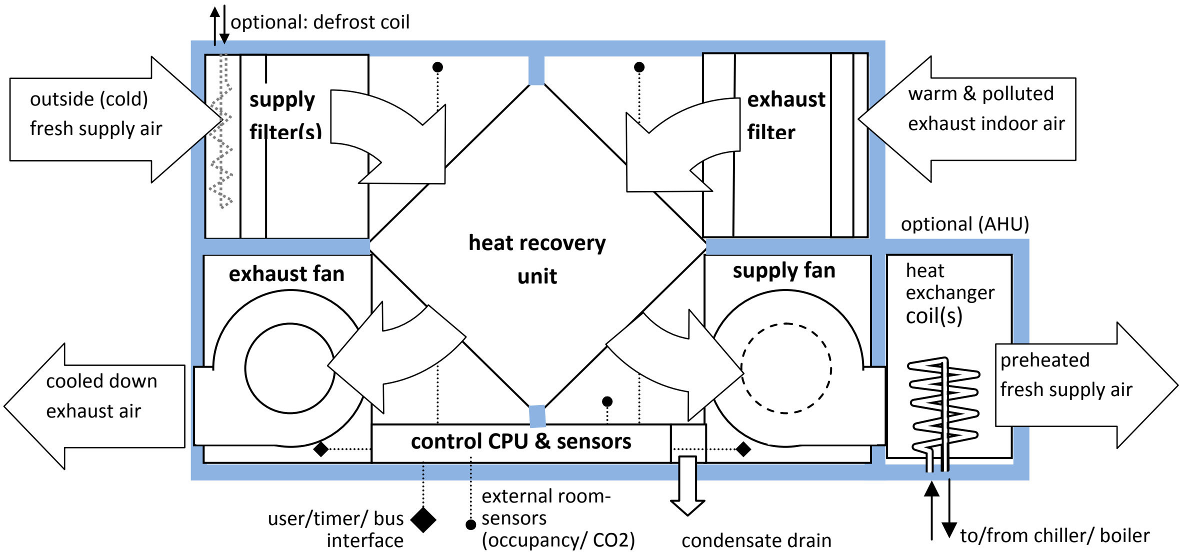

Figure. Balanced unit, with heat recovery (winter operation)

Preliminary key findings

The mechanical ventilation unit is both an 'Energy-using Product' (EuP), in the sense that it consumes electricity, and an 'Energy-related Product' (ErP), in the sense that it saves on space heating (and space cooling) energy of the boiler (and chiller) with respect of a reference situation without mechanical ventilation, at equal performance in terms of indoor air quality and at average climate and boiler(chiller) efficiency.

Today, the energy-saving *ErP-effect* is more than 4 times higher than the energy consuming *EuP-effect*, leading to a significant net saving with each new mechanical ventilation unit that is used instead of natural ventilation.

The quantitative assessments in the Task reports 1 to 5 strongly indicate that the products in the scope are eligible for Ecodesign measures: The units themselves represent a significant and growing sales volume in industry. Moreover, economically they are also the core of a host of other products (installation components) and services (trade and installation), contributing to GDP and job creation. The products in the scope represent a share of 4,5% of total EU electricity consumption (equal to the total electricity consumption of the Netherlands). But at the same time, also taking into account that electricity consumption, they are responsible for a >10% net primary energy saving on the EU's space heating bill.

There is plenty of opportunity for growth in primary energy saving through retrofitting and new sales. As much as 60% of the total non-domestic and collective domestic building stock could benefit from optimised mechanical ventilation, with demand side control, heat recovery ventilation or both. At the same time, there is still a large saving potential regarding the ventilation electricity consumption through, amongst others, brushless DC motors, variable speed drives, direct drives, smart controls, lowering the internal pressure drop of filters, heat recovery units.

Market transformation will be slow given the inertia of the building stock and projections will be subject to significant uncertainties. Savings will vary depending on the effect of parallel measures such as space heating boiler efficiency improvement and lowering of infiltration rate. Furthermore, there is anecdotal evidence that with current natural ventilation practise the indoor air quality is often unhealthy. Replacing an unhealthy practice by a healty one will reduce the mechanical ventilation savings effect, but improves the indoor air quality significantly during the heating season.

Art. 15 a) Economic significance	Annual unit sales 1,1 mln. exhaust and 0,32 mln. balanced units; EU-27 stock: 19 mln. units installed. Industry revenues of units ca. € 2,7 bln./a; related revenues in installation products and services ca. € 20 bln./a.
Art. 15 b) Environmental impact	The use phase makes up >99% of the total environmental impact, with energy and related emissions as relevant indicators. *EuP-effect*: Electricity consumption 127 TWh/a (457 PJ primary energy), causing 51 Mt CO_2 eq./a carbon emissions. *ErP-effect*: Saving on space heating 2.065 PJ/a, responsible for 120 Mt CO_2 eq./a emissions. Net saving impact today (EuP minus ErP): 1.608 PJ/a and 69 Mt CO_2 eq./a.
Art. 15 c) Improvement potential	4000 PJ/a extra saving on space heating, equivalent to ca. 200 Mt CO_2 eq. /a. Electricity consumption at 2010 level (127 TWh/a). *(preliminary estimate, to complete at Task 7)*

Tasks and reporting

The structure and content of the Tasks follow the tender specifications and the MEEUP methodology[2]. The reporting structure follows the Task structure. The structure of chapters/paragraphs within each Task report may deviate from subtask-structure if it serves better understanding and readability. If this is the case, it will be clearly indicated in the first, introductory section of each Task report.

Task 1 classifies and defines the energy using products covered by this ENTR LOT 6 Air Conditioning and Ventilation Systems study and the 'level playing field' for Ecodesign. Furthermore standards and existing legislation for the defined energy using products is investigated.

Task 2 entails the economic and market analysis of ventilation systems that use individual fans with an electric power input larger than 125 W. Furthermore, the task report is to supply the necessary economic ingredients for subsequent tasks.

The main focus in task 3 is on user requirements. Relevant user parameters are an important input for the assessment of the environmental impact of a product during its use and end-of-life phase.

Task 4 entails the assessment of average EU product(s) that have to be defined as representative product "Base-cases" for the whole of the EU-27. On these Base-Cases most of the environmental and Life Cycle Cost analyses are built throughout the rest of the study. The base-cases are the point of reference for tasks 6 (improvement potential) and 7.2 (impact analysis).

Best available technologies (BAT) and Best not yet available technologies (BNAT) are analysed in Task 5. The environmental performance of BAT and BNAT both provide part of the input for the identification of the improvement potential analysed in task 6.

Preview task 6 and 7

Task 6 is about Ecodesign improvement potential, this is done by identifying design options, their monetary consequences in terms of Life Cycle Costs (LCC) for the user, their economic and possible social impacts, and pinpointing the solution with the Least Life Cycle Costs (LLCC) and the BAT.

Task 7 entails the policy-, scenario- and impact analysis, based on all preceding tasks. It looks at suitable policy means to achieve the potential. It draws up scenarios 1990-2020/'25 quantifying the improvements that can be achieved versus a Business-as-Usual scenario and compares the outcomes with EU environmental targets, the societal costs if the environmental impact reduction would have to be achieved in another way. Impacts on consumers and industry will be assessed.

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[2] http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/methodology/index_en.htm; Kemna, R. et al., Methodology for Ecodesign of Energy-using Products (MEEuP), VHK for European Commission DG ENTR., Nov. 2005.