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Building on the Ecodesign Directive –
Energy-Using Product Group Analysis/2**

Lot 6: Air-conditioning and ventilation systems

Contract No. ENTR / 2009/ 035/ LOT6/ SI2.549494

Draft Report Task 3

User requirements

on *Ventilation Systems* for non residential
and collective residential applications

Prepared by VHK

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Summary

This is the draft report for Tasks 3 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.**

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.

The main focus of the report is on the combined subtasks 3.1 and 3.2, i.e. user requirements

Chapter 1 gives the introduction on the assignment, subtasks, methodology and reporting.

Chapter 2 gives a general introduction into the available ventilation systems and gives an overview of drivers and barriers

Chapter 3 supplies estimates of ventilation-demand on the basis of some general EU-wide parameters: number of persons and buildings, ventilation losses as a part of total heat loss. And it gives some very interesting examples of the few cases where it was possible to retrieve exactly the right data.

Chapters 4 (multi-family dwellings), 5 (public sector buildings), 6 (services) and 7 (primary and secondary sector) discuss the building stock and ventilation-requirements in greater detail. Especially Chapter 5 on public sector buildings is interesting and contains a considerable amount of original material. It makes plausible that the public sector is performing under par in the field of energy efficient ventilation.

A summary of the ventilation demand is given in chapter 8, showing that (at least) 60% of the building volume is ventilated through natural ventilation. Of the 40% mechanical ventilation, 19% are simple exhaust (or supply) systems, 15% are balanced (exhaust + supply) systems without heat recovery and balanced heat recovery ventilation is installed in only 7% of the building volume. In terms of products, it is reported that multi-family and non-residential buildings around 20 mln. rooftop/ boxed fans are installed and around 3,1 mln. air handling units. The saving potential is considerable.

The final ‘Miscellaneous’ chapter 9 reports on information found through the Lot 6 information request and touches on subjects like the end-of-life, the influence of climate on heat recovery, leakage of ductwork and the (lack of data on) controls and control settings.

The Task report is accompanied by a separate ANNEX report that gives further details on especially the statistical information.

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Acronyms

| | |
|------|-----------------------------------------------------------|
| HVAC | Heating Ventilation and/or Air-Conditioning |
| HR | Heat Recovery. |
| HRV | Heat Recovery Ventilation |
| LHRV | Local Heat Recovery Ventilation |
| CHRV | Central Heat Recovery Ventilation |
| VRF | Variable Refrigerant Flow |
| VAV | Variable Air Volume |
| CAV | Constant Air Volume |
| VSD | Variable Speed Drive (a.k.a. ASD, Adjustable Speed Drive) |
| AHU | Air Handling Unit |
| Pa | Pascal (SI-unit of pressure) |
| AC | 1. Air Conditioning 2. Alternate Current |
| IAQ | Indoor Air Quality |
| SFP | Specific Fan Power (in W per m ³ /s) |

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1 Introduction

1.1 Scope and subtasks

This is the draft report for Task 3 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.**

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.

1.2 Task 3

Task 3 deals with the real-life energy consumption, as depending on consumer behavior and infrastructure. In this case the general scope is ventilation in collective residential buildings and ventilation in non-residential buildings. General guidance on this task is given by the MEEUP methodology study (VHK 2005).

For this product group the offer of the consortium distinguishes 3 subtasks for Task 3:

Subtask 3.1 User Requirements

This subtask will gather information on what relevant building characteristics in the tertiary and residential sector, including typical ventilation requirements are.

Building-types to be distinguished are for example:

- residential buildings (flats, apartment blocks, elderly homes, care homes)
- offices
- schools and other educational buildings
- sports centre's, gyms
- café's, bars and restaurants (with and without smoking facilities)
- hotels
- hospitals
- ecclesiastic buildings
- etc

For each building type the following items are to be identified:

- Number of buildings
- Heated Gross Floor Area (m²) and/or building volume (m³)
- Number of occupants (determines ventilation requirement)
- Typical occupancy in time (setback and peak periods for ventilation)
- Activities and processes in as much as they are relevant for (special) ventilation needs

Under certain circumstances also the employment of certain materials may be relevant. For example, the abatement of radon emissions through ventilation in Greece.

Furthermore, in this subtask information will be gathered on:

- the user-perception of the mechanical ventilation systems (preferences and nuisances).
- health and productivity of the occupants/employees in relation to IAQ and ventilation systems;
- the decision making process in the various market, i.e. drivers and barriers for the introduction of more efficient ventilation.

Subtask 3.2 – User requirements in the use phase (current situation)

The objective of this subtask is to assess the typical physical and operating conditions of the ventilation systems in Europe.

Information will be gathered concerning:

- residential and tertiary buildings characteristics (amongst which air tightness, A/V-ratio)
- penetration of mechanical and natural ventilation systems versus no ventilation systems
- the average IAQ (Indoor Air Quality) and comfort levels in these buildings
- typical physical characteristics of the different building types in Europe

This statistical information will be used to represent typical buildings and their associated ventilation systems and IAQ-levels.

These data will be used at a later stage/task to model energy consumption in typical operating conditions of ventilation systems. It will integrate not only air change systems but also heat recovery and various kinds of controls.

Finally, this subtask will try to gather information on the energy losses that are caused by improper maintenance (or no maintenance at all) of the ventilation systems.

Subtask 3.3 –End-of-Life behaviour

This subtask will gather information on the end-of-life phase of mechanical ventilation systems. The recyclability of related products and components will be assessed as well as the environmental waste related to these products and components. The information, if available, will be gathered nationally via professional national association (questionnaire).

1.3 Methodology and reporting

Information was gathered through desk research, questionnaires (information request to stakeholders May 2010) and engineering calculations. As data availability is poor, both on ventilation systems and on the tertiary sector, it will often not be possible to derive the required data directly from European (Eurostat) statistics.

Instead, the contractors have tried to construct the information on the building stock from a multitude of sources. The most important source for setting a general framework is the VHK Business & Public Sector Statistics project. This project is a comprehensive internal VHK assessment of the number of EU-companies at NACE 5-digit level. The project on started in autumn of 2007 as an internal research project. It pulls together the data not just from Eurostat, but mainly from national NACE statistics. Although the project is still ongoing, it is – to our knowledge—the only source that reaches this level of detail for all EU-25 countries, whereby Romania and Bulgarian data are added through an overall multiplier in order to

arrive at the EU-27. The statistics are the property of Van Holsteijn en Kemna B.V. (VHK), but –as VHK is part of the consortium—it was decided to make the data at least on EU totals available to the public domain. The full table is given in Annex I.

On the basis of these statistics, subsequent specific sources concerning ventilation were used to depict the current situation and the actual ventilation need.

In the report, but also in the research, the subtasks 3.1 and 3.2 were combined and discussed per sector (residential, public & community sector, services sector, etc.). Subtask 3.3 is treated in a different chapter.

Per sector the aim is to provide answers to three questions:

- How (much) are people ventilating their buildings today?
- How much energy is involved with that?
- What would be ideally --given the functional demands and the infra-structural possibilities-- their ventilation need?

Task 1 provides most part of the input for the third question, in terms of the ventilation need in m³/h (or m³/s) per person, per m² gross floor area or per m³ heated building volume. Furthermore, the prescriptive parts provide some inputs into pressure drops that can be expected, minimum efficiency standards at national level, etc..

Task 2 results will provide part of the answer to the second question, i.e. the part that deals with the EU electricity consumption and design data of mechanical ventilation units. However, the bulk of the effort will be to determine the real-life use (control) of the equipment and above all the heating energy loss through ventilation.

How much energy would or should then be used in the ideal situation is subject to the technical possibilities and economic criteria in Tasks 4 and Task 5 respectively. Nonetheless, the Task 3 will already provide a first estimate.

Tasks 2 and 3 provide the inputs for Tasks 4 and 5, but also for the scenario analysis in Task 7/8 and will be very relevant for the Impact Assessment report that the European Commission ultimately will have to provide in case of Ecodesign legislation.

The report is set up as follows

Chapter 2 gives a general introduction into the available ventilation systems, as well as the main drivers and barriers for efficiency improvements.

Chapter 3 supplies estimates of ventilation-demand on the basis of some general EU-wide parameters: number of persons and buildings, ventilation losses as a part of total heat loss. And it gives some very interesting examples of the few cases where it was possible to retrieve exactly the right data.

Chapters 4 (multi-family dwellings), 5 (public sector buildings), 6 (services) and 7 (primary and secondary sector) discuss the building stock and ventilation-requirements in greater detail. Especially Chapter 5 on public sector buildings is interesting and contains a considerable amount of original material. It makes plausible that the public sector is performing under par in the field of energy efficient ventilation.

A summary of the ventilation demand is given in chapter 8. The final ‘Miscellaneous’ chapter 9 reports on information found through the Lot 6 information request and touches on subjects like the end-of-life, the influence of climate on heat recovery, leakage of ductwork and the (lack of data on) controls and control settings.

The Task 3 report is accompanied by a separate ANNEX report that gives further details on especially the statistical information.

2 General

2.1 Ventilation systems basics

As mentioned in the Task 1 report on ventilation, there are basically 4 types of central ventilation systems that are currently used and referenced in standards and building regulations (EPB):

- Natural ventilation (' System A')
- Supply ventilation (' System B')
- Exhaust ventilation (' System C')
- Balanced (supply & exhaust) systems ('System D'), often with heat recovery

Furthermore, ventilation systems that are based on local heat recovery ventilation (LHRV) units are increasingly referred to as 'System E'.

System B is rare for 'ventilation only' products for the residential sector, but in non-residential it is a solution that can mostly be found in AHU's, i.e. where ventilation is combined with air cooling (see par. 2.2).

System D in the residential sector (currently mostly in individual dwellings) is always combined with heat recovery, but in the non-residential sector still around half of the AHU's, where ventilation is combined with air-cooling, is delivered without a heat recovery unit.

Any of these above systems may and sometimes –e.g. for residential configurations of System E-- must be supplemented by simple local extraction fans for occasional use in the 'wet rooms' (kitchen, bathroom, toilet). Kitchen hoods are not part of 'comfort ventilation', but in most standards and building regulations they are perceived as 'process ventilation' and taken into account with default values for an overall ventilation calculation of a building. Also other types of process ventilation, like the ventilation of operating theatres, clean-rooms and mines (see Annex II), extraction of toxic fumes in industrial processes, etc. are not regulated through building regulations and are outside the scope of the underlying study.

The diagrams on the next page show the principle.

In terms of energy efficiency and ventilation effectiveness the 5 systems are (very) different:

- System A has the advantage that there is no electricity consumption, except perhaps for some simple extraction fans in case the passive stack (if it is foreseen) does not provide sufficient ventilation. But the ventilation heat losses are very high. In order to work properly, infiltration openings in outer doors, inner doors and in window frames are a necessary part of the building design. Infiltration rates of 0,6 m³/h per m³ building volume are quite the normal standard. On top of that the inhabitants will have to open all windows periodically (best practice, DE. 'Stosslüften') or leave a small window open (worst practice), adding another 0,6 to 0,8 m³/h per m³. The driving force behind sufficient natural ventilation is the pressure difference between opposite sides of a building. In other words: the wind. And the wind has some disadvantages: It is highly unpredictable and it usually blows only in one –unknown–direction.

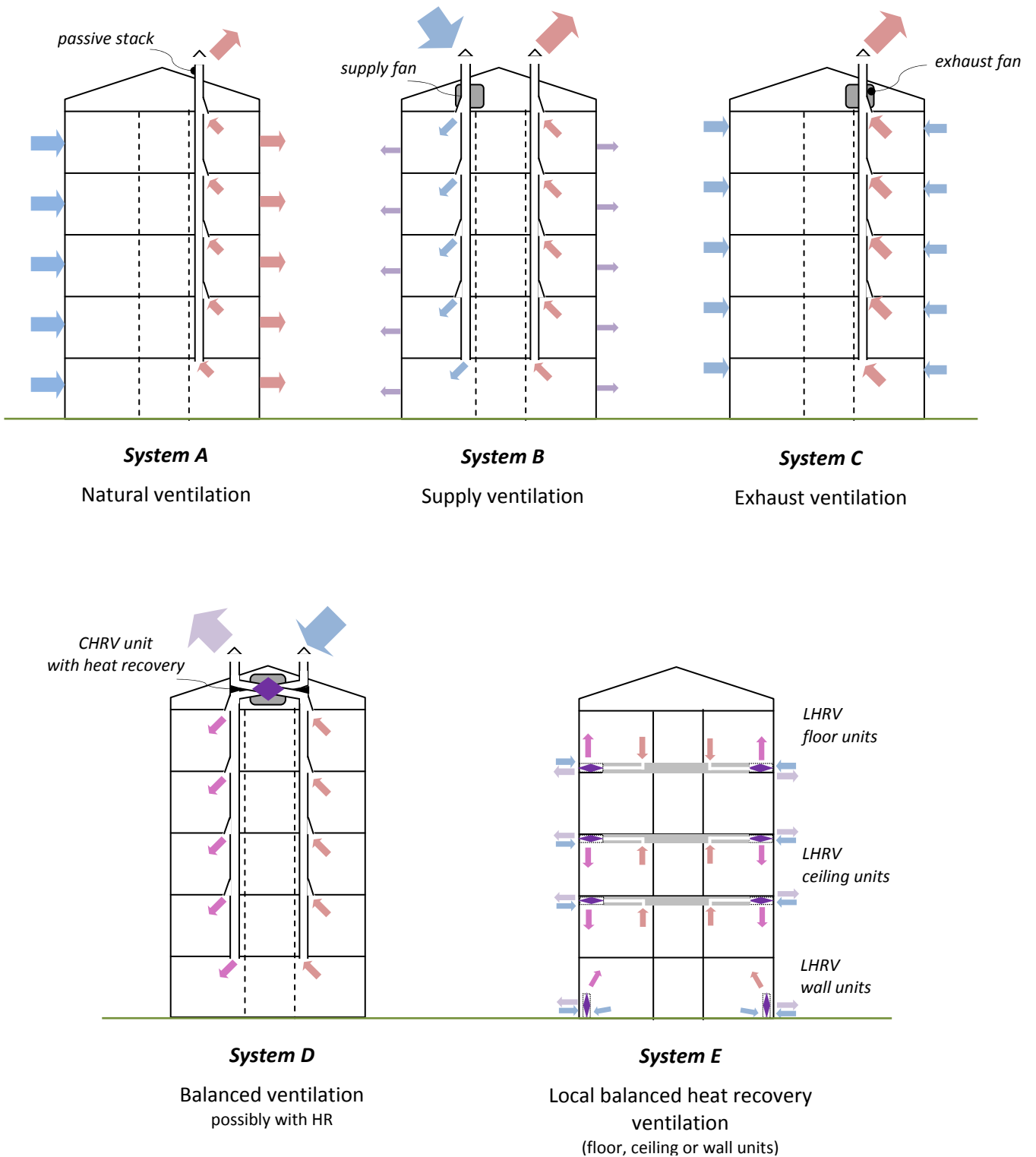


Fig. 1. Basic ventilation systems

So in order to make sure that under all circumstances there is enough ventilation for a healthy indoor climate, the building regulation are very generous in prescribing the size of infiltration openings needed. System A provides a low level of comfort. If there is no wind, ventilation tends to be insufficient. If there is too much wind, there are cold drafts.

- **System B** in a normal building and used for ‘ventilation only’ is not an energy efficient way to ventilate a building. The over-pressure (with respect to outdoors) increases the infiltration losses and in order to guarantee a proper functionality under the worst circumstances (i.e. the wind blowing hard against the façade) the fan has to be fairly over-dimensioned. Therefore it is only used in legacy air-conditioning systems or in special (‘process ventilation’) circumstances, e.g. in operating theatres of hospitals where it is important to keep the bugs out.
- Until recently, **system C** has been THE central mechanical ventilation system for residential dwellings (multi-family or not). Air enters living- and bedrooms through special openings (grids, usually with noise damper to keep out outdoor noise) and is extracted through special openings in the wet rooms (kitchen, bathrooms) by a central exhaust fan. In non-residential buildings the exhaust openings are usually placed in the corridor. Unlike system A, its performance does not depend on the wind and in theory (most people leave the fan at mid-position all year round) there is the possibility of flow-rate control. These qualities allow buildings to be as air-tight as possible (with the exception of the special openings in the façade), thereby saving considerably on the infiltration heat losses and gaining in comfort and IAQ. On the downside, system C consumes electricity. It may not be very much with respect of the heating losses avoided, but it still counts. On the performance side, the possibility to control the airflow is rarely used. In non-residential buildings there may be a night-setback timer switching back from 100% (!!) to 50% capacity, but in (multi-family) buildings the fan is running in a mid-position (60% capacity) all year around. Furthermore, the special openings lead to cold drafts as well and in many occasions people keep these openings closed, resulting again in bad air quality with CO₂-levels well over 1200 ppm (example: NL primary schools).
- **Systems D** and E, when combined with heat recovery, represent the most efficient ventilation solution today. State-of-the-art heat exchangers reach an (initial) heat transfer effectiveness of close to or over 90%. This means that the incoming air is almost completely preheated (or pre-cooled in summer) to the room temperature. System D is the system of choice in air handling units (AHU’s) for (larger) non-residential buildings. But the traditional reason was not energy efficiency, but because it is the best solution to provide comfortable air-conditioning (air cooling). For that reason, although 80% of AHU’s has balanced ventilation only half of currently sold units are equipped with a heat recovery (HR) module, ignoring the strong pressure from legislation in the Northern parts of Europe. In 2005 the share of HR in German AHU sales was only 29% and therefore the stock of HR units will probably be no more than 20-25%. For the smaller public sector buildings there are some developments pushed by legislation whereby the construction industry is realizing balanced ventilation with special ‘ventilation only’ centralized heat recovery ventilation units, typically in a range between 500 and 4000 m³/h. But there is still a long way to go.
- **System E** has the advantage of heat recovery (>80%) as system D, but it has a number of extra advantages: Mainly –depending on type—it is easier to retrofit in existing buildings (no ductwork) and it is easier to realize local control. Local control means that the ventilation unit can take into account the occupancy and the user preferences per room/workplace, using local CO₂ and humidity sensors and local manual override

options. These features can be realized with system D (centralized systems) and C, e.g. by using VAV terminal boxes per room and local sensors/actuators that communicate with the CPU, but it is a solution that comes at a cost-penalty and requires well-trained staff. On the performance side, system E has the advantage of very little –if any– ductwork, which usually is easy to clean. A disadvantage of system E versus system D is that it is usually not suitable for use in tall, single shell office buildings (>6 to 8 floors), which might experience a high wind load on the upper floors. For buildings with a double façade, which may be a good choice for other reasons as well, there is no problem; alternatively, some central ductwork may be required.

The diagram below gives a qualitative impression of the primary energy losses associated with the currently most used systems A, C and D/E.

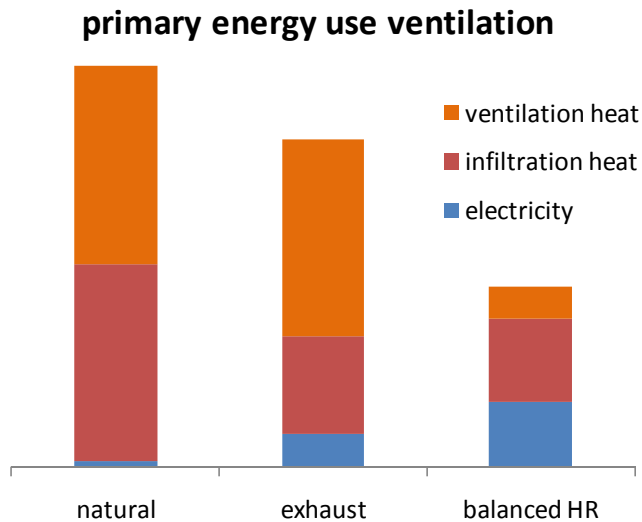


Fig. 2.

Please note that these are average efficiencies. Within each category the best practice in terms of controls and ductwork can give a >30% improvement. This is to be further elaborated in the Technical Analysis (Task 4/6).

2.2 Ventilation requirements

The task 1 report gives the ventilation requirements according to the European standards. The IAQ-level III corresponds with CO₂-level of ca. <1200 ppm (800 ppm higher than the outdoor CO₂-level)

Table 1 . EN 15251:2007. IAQ category III (IDA3), Low-polluting building. Examples of recommended air flow for ventilation per m² or m³ heated floor area**

| Type of building or space | floor area in m ² /pp | for occupancy l/s/m ² | for building l/s/m ² | TOTAL l/s/m ² | TOTAL | floor height* | TOTAL* |
|---------------------------|----------------------------------|----------------------------------|---------------------------------|--------------------------|----------------------------------|---------------|----------------------------------|
| | | | | | m ³ /h/m ² | | m ³ /h/m ³ |
| Single office | 10 | 0,4 | 0,4 | 0,8 | 2,88 | 3,60 | 0,80 |
| Land-scaped office | 15 | 0,3 | 0,4 | 0,7 | 2,52 | 3,60 | 0,70 |
| Conference room | 2 | 2 | 0,4 | 2,4 | 8,64 | 4,20 | 2,06 |
| Auditorium | 0,75 | 6 | 0,4 | 6,4 | 23,04 | 15,00 | 1,54 |
| Restaurant | 1,5 | 2,8 | 0,4 | 3,2 | 11,52 | 4,20 | 2,74 |
| Class room | 2 | 2 | 0,4 | 2,4 | 8,64 | 4,20 | 2,06 |
| Kindergarten | 2 | 2,4 | 0,4 | 2,8 | 10,08 | 4,20 | 2,40 |
| Department store | 7 | 0,9 | 0,8 | 1,7 | 6,12 | 6,00 | 1,02 |

*= floor height and therefore recommended air flow in m³/h/m³ are VHK estimates

**= ventilation excluding infiltration. For new buildings the standard infiltration is around 0,25 m³/m³.h.

IDA3 is the CO₂-level most commonly used in energy performance legislation for non-residential buildings. IDA2 can be found in Scandinavian recommendations for certain building-types (e.g. schools). IDA1 is found in some hospitals and laboratories. The required air flow in operating theatres and cleanrooms, which are considered process ventilation and outside the scope, are far beyond the IDA1 level in terms of hourly air-flow (10-20 m³/m³) and for the requirements of air purifications are a class of their own. On the downside, there are several applications in heavy industries and mining, where the IDA3 level cannot be reached and –with specific rules for temporary exposure—workers have to settle for IDA4 or worse.

For (multi-family) dwellings the minimum recommended ventilation flow rate is 0,9 l/s/m² (ca. 1 m³/m³).

2.3 Drivers and barriers

Most Europeans, apart from those suffering respiratory diseases, will only think of ‘ventilation’ in case of bad smells, drafts or steamed up mirrors, usually remedied by opening the windows. In very new houses, people will be aware of excess humidity, because the cement is still drying out. But after a few months that problem is over and the focus is just on the kitchen, bathroom and toilet areas, where some may or may not use a small extraction fan to get rid of smells and vapour.

Few are aware to have ‘ventilation’, i.e. that their residence or work-place is designed to guarantee a minimum amount of air change for health, comfort and building protection. For most, the drafts from consciously applied openings below or inside doors and windows are just a nuisance.

The lack of awareness on the necessity of ventilation with the general public was clearly demonstrated in the 1980s and 1990s when several authorities induced people to close all these drafty 'holes' for reasons of energy saving but without stressing the need to take appropriate measures to still guarantee a proper air change. The resulting bad indoor climates at least prompted the authorities to take a more serious look at 'ventilation', spurring the introduction of heat recovery solutions very often at the level of mandatory building regulations.

The awareness of ventilation, the user-habits and the policy in the field of 'ventilation' varies very much from the North to the South of the European Union.

The above attitude applies very much to the middle of Europe, with countries like the Netherlands, Germany, the UK, Northern part of France and Belgium, where heat recovery products have been on offer for the last 15 years and have become mandatory in building regulations for new buildings over the last decade. But with the slump in the construction industry, market penetration is growing only very slowly and ownership in the residential area is estimated at 1-2%.

In larger commercial buildings, where heat recovery units are an addition to the modular air-handling units, the market penetration of heat recovery is growing very rapidly, but still the overall penetration per m² gross floor area may not be more than 5-10%.

For instance, a 2003 Belgian survey of office buildings, relatively 'easy' to tackle with central ventilation, showed that only about 50% of the buildings had a balanced mechanical ventilation. Less than 20% had an exhaust or supply ventilation and 31% had no mechanical ventilation at all.

In the year 2000, the Finance minister of the German district ('Land') of Baden-Württemberg (approx. 10 mln. inhabitants) reported that 35% of its university buildings and only 15% of its other 6000 public administration buildings had HVAC-installations. In other words, 65% of university building and 85% of public administration buildings had no centralized ventilation at all. Remarkably, the Green Party that prompted the Finance minister to release these figures was only concerned over the electricity costs of the fans and did not mention the much more important issue of abating the ventilation heating losses at all.

In 2009, German air-handling-unit manufacturers reported that around 40% of total units sold (50% of balanced units) featured heat recovery units, whereas in 2005 it was only 23%. Still, with new construction being slow and the potential for retrofitting existing buildings being low, this still doesn't amount to much. In total it is estimated that market penetration in mid Europe is around 10%.

In Scandinavia, heat recovery ventilation was made (semi-) mandatory for new buildings – residential and non-residential—already in the early 1980s and the market penetration in the building stock is relatively high, i.e. estimated at over 50% of the commercial and multi-family buildings. Still, Sweden and Finland constitute only 3% of the EU building stock.

In Southern-Europe, heat recovery ventilation is practically unknown in multi-family buildings, unless in the alpine areas. For commercial buildings it may be used as a means to cut down on the cooling (air-conditioning) costs in summer, but exact numbers are not known.

2.3.1 Barriers

The major barriers for making heat recovery ventilation more attractive are

1. The capital investment is still the main barrier. A 2009 Taylor Wessing report confirms that this is true for any investment in 'sustainability' for non-residential buildings and the more efficient, heat recovery ventilation is no exception. The Taylor-Wessing report mentions the "vicious circle of blame". That is a self-perpetuating cycle, when:
 - a) end users claim that not enough sustainable buildings are available;
 - b) designers and constructors say that developers don't ask for sustainable buildings;
 - c) developers assert investors won't pay for them; and
 - d) investors claim they would respond, if only there was demand from end users.
2. Lack of awareness on both health and energy aspects of ventilation. Few people are aware that one-third or even half of their space heating bill is due to 'ventilation'. Still fewer people are aware that the ventilation heating energy losses can be tackled with heat recovery systems.
3. Lack of knowledge. Even if all decision-makers are aware of the need for sufficient ventilation and the energy saving potential, it is often very difficult to find advisors and installers that are well-informed and properly trained. This does not only concern small electrical installers being unfamiliar with heat recovery ventilation. For many of big installation firms dealing with larger commercial buildings, ventilation is part of air-conditioning, i.e. cooling and air heating. Design calculations and lay-outs that provide best price/quality for 'ventilation only' are therefore rare. This is especially true for retrofitting existing buildings where there are significant opportunities for heat recovery ventilation linked with renovation of the facades or even simple retrofitting with the latest decentralized heat recovery ventilation products.
4. Asymmetric economical information. Consumers are not able to consider the cost-efficiency of the use of heat recovery ventilation and the full life-cycle costs. The purchase price is well visible and is considerably higher for heat recovery ventilation. On the other hand, information on running costs/cost savings is not explicit and can be obtained only with difficulties. For instance for a 14.000 m³/h AHU's the heat recovery unit makes up € 19.000 on a total capital investment of € 58.000 for a ventilation + heat recovery unit.
5. Split responsibilities and budgets. Especially in multi-family buildings and commercial buildings the builders, installers and users of ventilation systems are not the same entities and do not have the same budgetary priorities. Builders and developers want to cut down on building costs. Because the ventilation systems is one of the last items to be installed/purchased and usually a low-interest product with future buyers/users of the building, it is a perfect item for cost saving. Buyers of the building and building authorities increasingly value low energy buildings, but commercially it is often more attractive to boost some sort of renewable installation (solar, heat pump) than highlighting a heat recovery ventilation system. The users of the buildings have to pay the energy bill, but very often have no say (and expertise) in how the buildings' installations should be improved.
6. The 'packaging' with air-conditioning. For many decision makers on the equipment in buildings, centralised ventilation is still very much linked to air-conditioning, i.e. space cooling. And given a fixed budget, the price of an installation with heat recovery may become prohibitively high. In many instances, space cooling is seen as a big bonus (e.g. 4-star hotels) or even a necessity (labour conditions). On the other hand, heat recovery ventilation –given the lack of awareness– is just an inconspicuous part of the building installation to help the building meet the minimum energy performance requirements. Few manufacturers of air-handling-units see heat recovery ventilation as a separate product in its own right, as a minimum necessity for every building,

cooled or not. For instance, Kaup mentions that despite the fact that the German energy saving act EnEV makes heat recovery ventilation one of the cheapest options to meet the overall requirements, still 60% of AHU's is sold without heat recovery.

7. The 'sick building' syndrome. Especially because of older air-conditioning systems with a significant degree of re-circulation and dust built-up in the venting ducts, many centralized ducted systems still have a bad reputation of spreading germs from co-workers and bacteria. If, as is often the case, the heat recovery ventilation is combined with a fair amount of recirculation heating or cooling air, also the commercial success of heat recovery ventilation may suffer.
8. Polluted ductworks. Heat recovery ventilation requires balanced mechanical ventilation. And balanced mechanical ventilation means that there are supply side ducts that may become polluted with dust and fungi on the long run. There is no risk of spreading germs from co-workers, but polluted ductwork has led to several health problems especially in the residential sector (e.g. in Amersfoort). The problem can almost always be traced back to a faulty installation (see paragraph on 'Barriers, Lack of knowledge') but it is giving balanced ventilation a bad name. This problem is aggravated by the fact that –in case of a faulty installation-- cleaning of the supply ducts is very difficult. Currently there is ductwork that is easier to clean, the filters are better and there are alternative (decentralized, not ducted) heat recovery ventilation solutions.
9. Noise. Another problem, again mostly due to faulty installations, is the noise which is transmitted from the central unit to living rooms and bad rooms. Solutions are the use of adequate noise dampers in the ductwork, lower noise production by the central unit, etc. but especially in the residential sector a part of the population will be sensitive to any type of extra noise.

2.3.2 Drivers

1. The main driver for heat recovery ventilation is national building regulations and specifically minimum energy performance requirements for (new or renovated) buildings. This is certainly the case in Sweden and Finland, but also the holistic approach in the Benelux, Germany, the UK and France makes heat recovery ventilation economically one of the best options to meet demands. However, as mentioned under 'barriers' the regulations relate only to new buildings and are successful in only half of the cases. In Southern and Eastern Europe the regulations for heat recovery are inexistent or (e.g. Italy) show significant loopholes.
2. Regulations on health and labor conditions play an important role, not so much in promoting heat recovery ventilation but at least in promoting mechanical ventilation systems to stay below the maximum pollutant levels (including CO₂). And in some cases the demand on ambient temperature necessitates air cooling, i.e. the need of balanced mechanical ventilation systems, even in areas and instances like the Netherlands and Belgium where indoor temperatures would exceed the maximum limits only 4-5 days a year. But there is no denying that once a balanced centralized air handling unit is installed that the step towards heat recovery is a simple and relatively cheap upgrade.
3. Sufferers of respiratory health problems. As mentioned in the previous paragraph, the general public and the professional builders are not the main drivers (see barriers), with the exception of some special interest groups like sufferers from asthma, hay fever and other respiratory health problems. These special interest groups do not have an interest in heat recovery as such, but they require high standards of air

purification/filtering which are difficult to achieve without balanced mechanical ventilation units. The heat recovery comes in only as an extra. With the ongoing rise of number of sufferers from respiratory health problems it also becomes more and more likely that in any multi-family building or commercial building they are amongst the inhabitants/ co-workers.

4. Another special interest that is driving balanced mechanical ventilation are health concerns of school-children. Schools represent a special ventilation problem because of the high density of people in a classroom requiring a high air flow rate. In this sort of situations, exhaust ventilation systems (air coming in through openings in the façade and extracted by a central fans) lead to uncomfortable drafts, which in turn induces personnel and pupils to close the façade-openings as much as possible. As a result the actual ventilation is insufficient, the CO₂-levels increase (far) above the maximum allowed and children start to suffer from headaches and other health problems, concentration loss and other symptoms of CO₂ intoxication. The solution is heat recovery balanced mechanical ventilation, which deals both with the comfort problem (because incoming air is preheated by outlet air) and the ventilation requirement.
5. Homes for the elderly and the elderly in general are a significant interest group that is very susceptible to cold drafts. Heat recovery ventilation provides pre-heated incoming air and is therefore a good solution to the problem.
6. Early adopters, not captured under any of the previous groups, which undertake to have heat recovery ventilation installed for energy saving, for economical and/or environmental reasons.

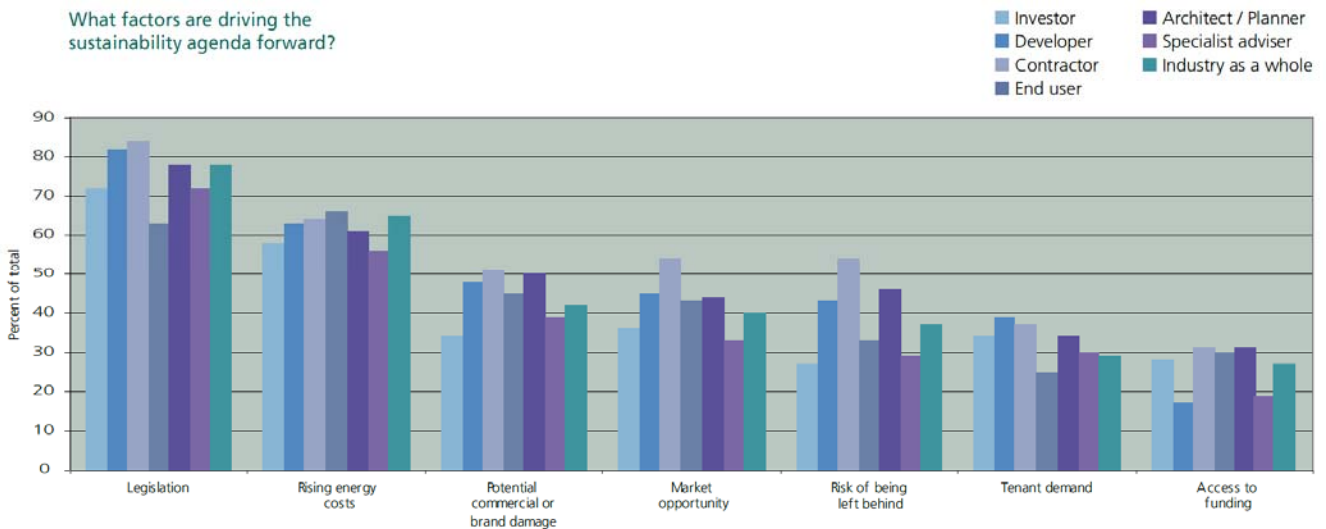


Fig. 10. The major driver is legislation. From: Taylor-Wessing, “Behind the green façade”, 2009. Survey amongst 800 professionals in the UK construction industry of non-residential buildings.

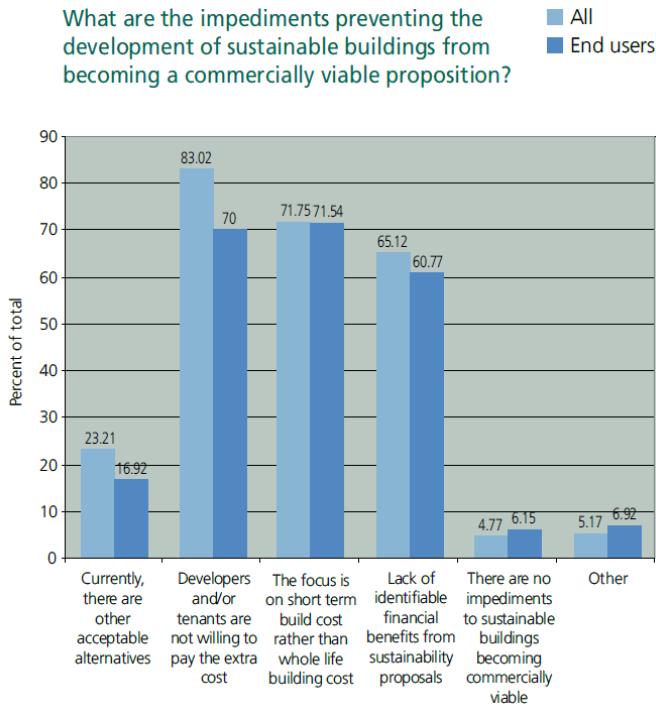


Fig. 11 . The main barrier is (investment) costs

From: Taylor-Wessing, “Behind the green façade”, 2009. Survey amongst 800 professionals in the UK construction industry of non-residential buildings.

The report also quotes the “vicious circle of blame”. That is a self-perpetuating cycle, when:

- a) end users claim that not enough sustainable buildings are available;
- b) designers and constructors say that developers don't ask for sustainable buildings;
- c) developers assert investors wont pay for them; and
- d) investors claim they would respond, if only there was demand from end users.

What type of approach is most likely to be effective in driving the change to improve performance in:

Existing building stock?
New building developments?

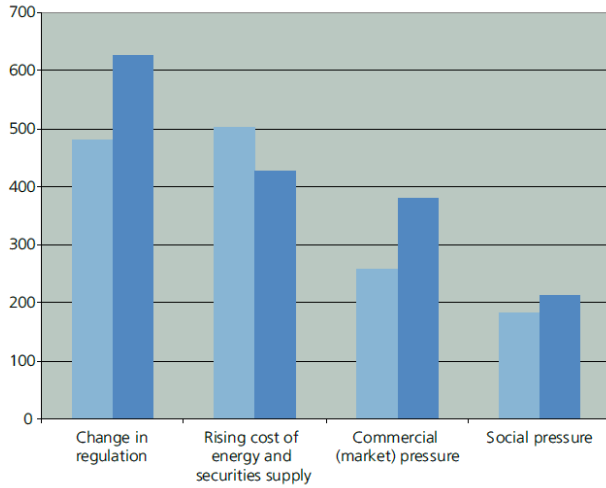


Fig. 12 . For existing building stock, rising energy costs may be the major driver.

From: Taylor-Wessing, “Behind the green façade”, 2009.

What type of government strategy will be most effective?

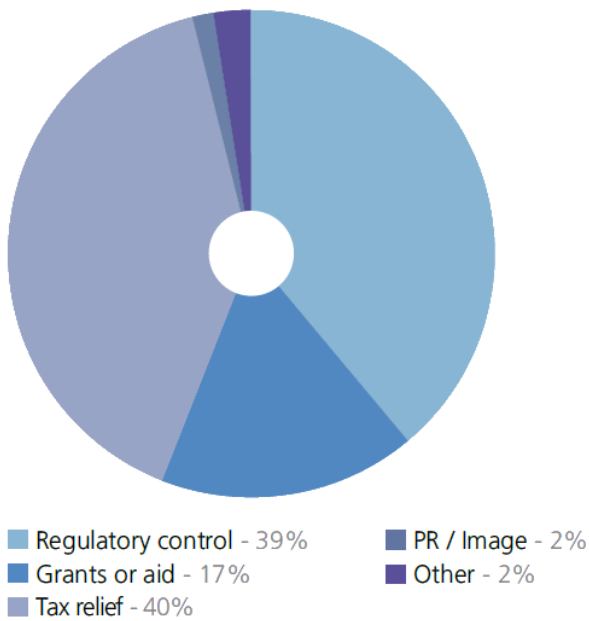


Fig. 13 . Government regulatory control and tax relief believed to be most effective

From: Taylor-Wessing, “Behind the green façade”, 2009.

3 Ventilation estimates by general parameters

3.1 Introduction

If, as is the case with ventilation systems, little quantitative data is available, it is customary – before trying to assess the status per sector—to make some dome estimates that at least will indicate an order of magnitude that can be expected. This ‘top-down’ approach is very useful to avoid that the more detailed estimates from a ‘bottom-up’ approach in the Chapters 4 to 7 gets out of hand.

To make these estimates a number of general parameters are used, for which a ‘best case’ and ‘worst case’ estimate is attempted:

- By number of persons that need ventilation
- By number of buildings and some general building parameters
- By type of building and specific floor area or volume.
- By estimating ventilation and infiltration losses as a fraction of the total heat loss of a building

3.2 By number of persons that need ventilation

For an IDA-3 level indoor air quality EN 13779 and EN 15215 recommend ventilation of 4 litres per second per person (4 l/s/p). Adding 25-30 % for infiltration/ventilation of the building, this results in approximately 20 m³/h.

In 2009 the EU-27 had a workforce of 248 mln. people. Taking into account unemployment and a number of part-time workers, it is estimated that the full-time equivalent (40h/week) of 200 mln. workers remains. Of these, there will be an estimated 20% working outdoors or at home, which brings the total to 160 mln. people working indoors.

On the other hand, also the outdoor workers will have some need for indoor space (at least meeting rooms) and of course there is a considerable amount of people that –voluntarily or not—spends part or all of its day in the non-residential sector: school-children and students (93 mln.), prisoners (0,6 mln.), people in homes for the elderly and handicapped, people in hospital (0,2 mln.), hotels (10 mln. beds) and people using transportation buildings (train, subway stations, airport terminals, etc.).

Therefore, an overall estimate of 250 mln. people in the non-residential buildings seems like a fair estimate. At 40h/week, 48 weeks (plus some overtime) each will use a non-residential building for at least 2000 hours per year. If they get exactly a ventilation & infiltration rate of 20 m³/h during these hours, the total annual ventilation requirement is 2000 h x 250 mln. people x 20 m³/h = 10.000.000 mln. m³ = 10 x 10¹² m³. This is the ‘best case’.

The much more realistic ‘worst case’ is that the workplace is often heated when they are not there. For instance, for an air-handling unit it is not unusual to ventilate 6 days a week with half of the time at half capacity and another half at full capacity (i.e. this means 18 full-time hours per day). During 52 weeks this makes a total of ca. 5600 hours per year. A large part of the people will be working with suboptimal ventilation (natural ventilation), so their hourly

air-flow will be not 1,05 but is estimated modestly at 15% more: 23 m³/h. The total annual ventilation requirement in non-residential buildings is thus 5600 h x 250 mln. people x 23 m³/h = 32.200.000 mln. m³ = 32 x 10¹² m³. This is a –fairly realistic–worst case estimate. The conclusion is that the annual ventilation air moving through EU non residential buildings should be between 10 and 32 x 10 Tm³ (T=Tera= 10¹²).

Note that this is an annual figure. Only during the heating season (5000 h/yr, 57% of the year) the displaced air was heated by a space heating system.

For the ventilation of multi-family dwellings the same method was followed.

The EU-27 has close to 500 mln. inhabitants. In the best case –at 20 m³/h/p and 8000 h/year¹–would require 80 Tm³ of fresh air per year. At work or school they would get already 10 Tm³, which means that 70 Tm³ of ventilation takes place at home. Around 220 mln. people (44%) of people are living in multi-family dwellings, which means that around 31 Tm³ of fresh air per year is needed for multi-family buildings.

In the worst case, the EU residential sector would need 8760h x 500 mln. people x 23 m³/h = 100.740.000 mln. m³ = 100 Tm³ of fresh air per year. This would come on top of the worst case non-residential ventilation of 32 Tm³. So the total is 132 Tm³ per year.

People in multi-family buildings would take up 44% of 100 Tm³, i.e. 44 Tm³. Together with the worst-case non-residential ventilation this means 76 Tm³ are in the scope of the underlying Lot 6 report. And an almost equal share of 66 Tm³ would be in the scope of DG ENER Lot 10.

3.3 By type of building and specific floor area or volume.

Annex IV shows the statistics of new building permits for several countries (DE, NO, FR, SV, UK). The statistics show at least the subdivision in building type that was used on the application: Offices, shops, schools, etc.. Especially in the non-residential sector this can be helpful to determine whether the detailed data are roughly correct.

On the other hand, the building permit statistics should also be used with care because e.g. ‘offices’ can be found in most any non-residential sector and the building permits may relate to extensions or renovations and not a complete building.

The diagrams below show an estimate of 4,74 mln. heated buildings in the tertiary sector and 2,67 mln. heated buildings in the primary and secondary sector. For multi-family buildings (see Chapter 4) the estimate is 12,7 mln. heated buildings. In total around 20,11 mln. buildings are possibly in the scope of measures for Lot 6.

¹ Assumed 10% outdoors or in transit

Main Building Types by Floor Area
(total 38,4 bln. m²)

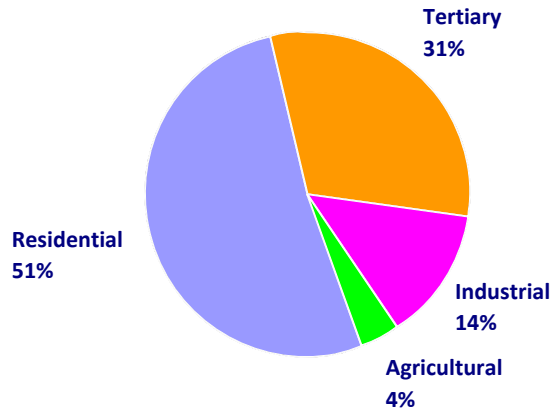


Fig. 14

Simplified approach: One- or two dwelling units, 110 m²/dwelling, Multi-family 65 m²/dwelling+125 m²/shop, tertiary 2500 m²/building, Industrial 2500 m²/building, agricultural greenhouses 5800 m²/building.

Main Building Types by Volume
(total 147 bln. m³)

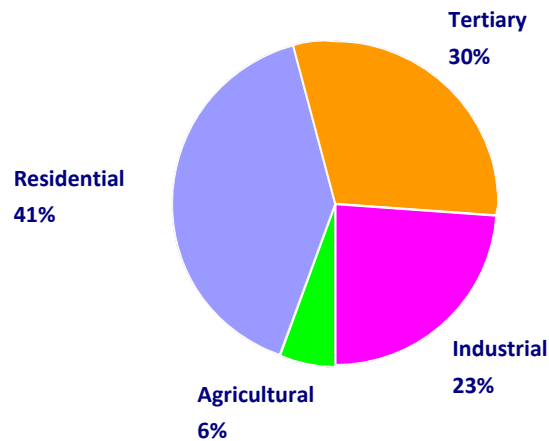


Fig. 15

tertiary sector UNITS

(figures in mln.units, total 4,74 mln. nonresidential buildings)

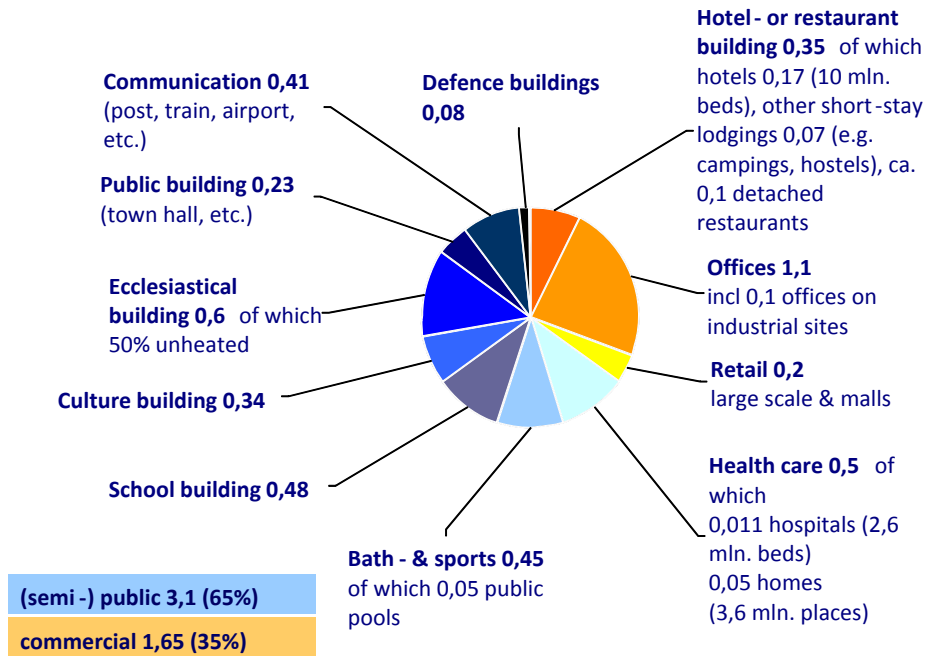


Fig. 16

EU -25 industrial etc. building UNITS 2003

(in mln., total 2,67 mln.)

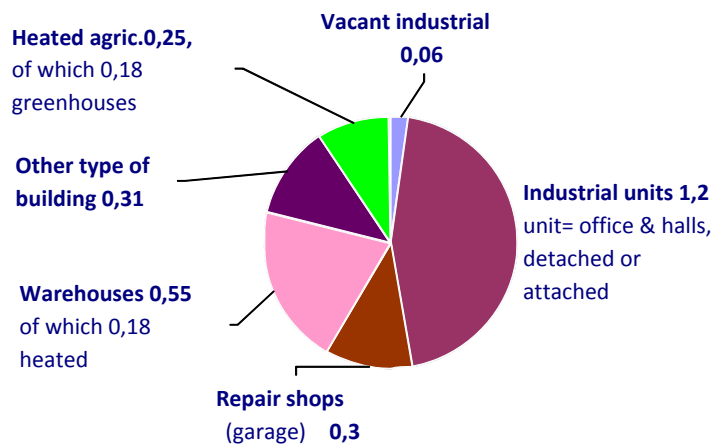


Fig. 17

3.4 By estimating ventilation losses as a fraction of the total heat loss

Ventilation and infiltration losses are around one-third (<1995) to half of the total heat losses (transmission + ventilation). On average they should represent around 35% of the total and this is also the suggestion of e.g. the ECCP statistics.

With data from the preparatory study for boilers (DG ENER, Lot 1) the total heat requirement of buildings can be calculated. That started from a total of 110 bln. m³ of heated volume at an average temperature of 18 °C.

The average European heating season is around 7 months (ca. 5000 hours), during which time the average outdoor temperature is on average 6,5 °C. In other words, there is a temperature difference between indoor and outdoor temperature of 11,5 °C. Around 2,5 °C out of this temperature difference is supplied by solar gains (sun coming through windows) and internal heat production of appliances and people. This leaves 9 °C to be supplied by an active heating system.

Lot 1 sets the average insulation value (U-value) of an average building is set at 1,2 W/K.m² and the average AV ratio is estimated at 0,5 m²/m³. For the average ventilation & infiltration rate Lot 1 assumes 0,75 m³/m³ (0,6 ventilation + 0,15 infiltration). The specific heat of air is 0,33 W/m³.K. The heating season is 5000 hrs. per year. The total heat load can thus be estimated as follows:

$$5000h * 9K * 110 \text{ bln. m}^3 * \{ 0,75 \text{ m}^3/\text{m}^3 * 0,33 \text{ W}/\text{m}^3.\text{K} + 0,5 \text{ m}^2/\text{m}^3 * 1,2 \text{ W}/\text{K}.\text{m}^2 \} = 4,19 \times 10^{15} \text{ Wh}$$

This means that the net heat load is 4.195 TWh with the proportion 1 : 2 between ventilation and transmission losses. The ventilation of heated buildings during the heating season would thus be 5000 x 110 bln. x 0,75 m³/m³= 412.500 bln. m³ (550 Tm³). The ventilation during the whole year (8760 h) would then be 723 Tm³.

This is more than **a factor 5 higher** than the worst case that was estimated on the basis of the personal ventilation requirements. A small part can be explained by the ventilation need of heated goods. But for sure it means that

- a) a considerable amount of over-ventilation is taking place, and
- b) it is vital to make the estimate of the building volume more robust, before drawing any final conclusions on the huge suspected saving potential is done.

With respect to the latter: In Europe most of space heating is done by a central heating boiler and the total systems efficiency, including all losses, is not more than 60% (2005) to 65% (2009).

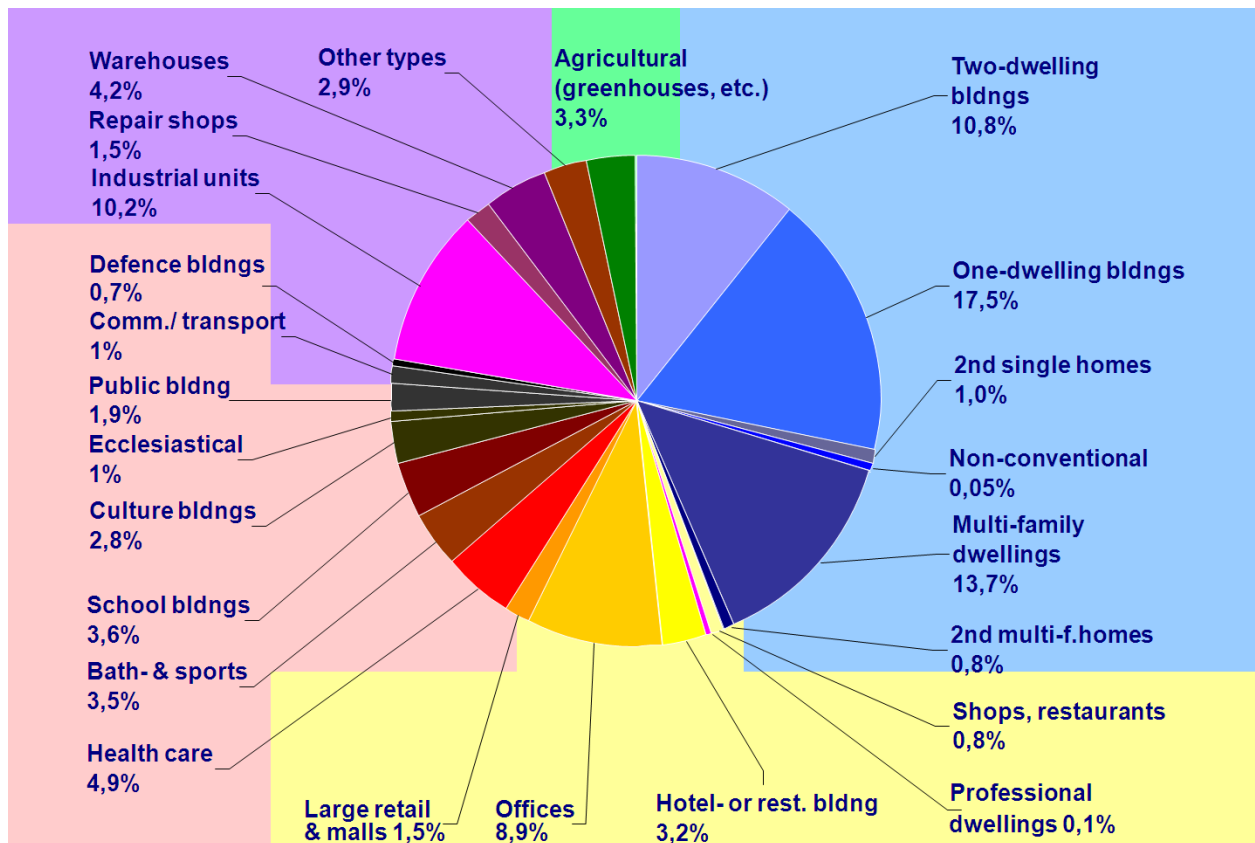


Fig. 18. Split-up of 110 bln. m³ heated volume equivalent at 18°C indoor temperature in the EU.

3.5 Examples

For Finland and Belgium sources were found that indicated the share of natural ventilation in certain sectors. These are only two countries out of 27 and the Belgian data only refers to the office sector, but it is information that can serve as a confirmation of a more systematic data search.

In that sense, the Finnish data are rather surprising. Finland is generally seen as one of the frontrunners in heat recovery ventilation and at least a decade ahead of the rest of Europe in this respect. However, the market penetration data shows that even in Finland (estimated 2002-2003) the share of HR ventilation was as low as 5% in existing individual housing and for new houses 25%. It was negligible in existing multi-family buildings and new buildings the share is 2%. Only in existing non-residential buildings the share was 30% and for new buildings of this type 70%.

Other interesting figure from this table relates to the 5-10% share of natural ventilation that is deemed unavoidable 2010, even for new buildings. It is assumed that this is due to infra-structural problems.

Table . Data for the Finnish ventilation market (Statistics Finland, VTT Building Technology databases, ca. 2003)

| | | Maximum potential deployment by 2010 | Current deployment level (% of stock) |
|---------------------------------------|-------------------------------------|--------------------------------------|---------------------------------------|
| Residential new built | <u>single-family housing</u> | | |
| | natural ventilation | 5% | 35% |
| | mechanical: exhaust | 95% | 40% |
| | mechanical: balanced HR | | 25% |
| | <u>multifamily housing</u> | | |
| | natural ventilation | | 10% |
| mechanical: exhaust | 100% | 88% | |
| mechanical: balanced HR | | 2% | |
| Residential existing | <u>single-family housing</u> | | |
| | natural ventilation | 75-80% | 85% |
| | mechanical: exhaust | 20-25% | 10% |
| | mechanical: balanced HR | | 5% |
| | <u>multifamily housing</u> | | |
| | natural ventilation | 30% | 40% |
| mechanical: exhaust | 70% | 60% | |
| mechanical: balanced HR | | - | |
| Non-residential new built | natural ventilation | 5% | 5% |
| | mechanical: exhaust | 95% | 25% |
| | mechanical: balanced HR | | 70% |
| Non-residential existing stock | natural ventilation | 5-10% | 15% |
| | mechanical: exhaust | 90-95% | 55% |
| | mechanical: balanced HR | | 30% |

In Belgium there has been a survey in 2003 on ventilation in office buildings (Kantoor 2003). The result was, that 31% used natural ventilation, 19% had either a supply of exhaust system and 50% had a balanced ventilation system of which an unknown share with heat recovery. This is surprising, because it is easily assumed that if there is one type of building where it is easy to realize balanced ventilation it is office buildings. And yet, only in half the cases balanced ventilation (probably in combination with air cooling) was realized.

In France the following penetration data were given.

Table 4: Market share for new residential buildings 2000-2004 (source: AIR .H, 2007)

| | Multifamily buildings (653 000 dwellings) | One-family houses (1.04 millions) |
|--------------------------------------------------------------|----------------------------------------------|--------------------------------------|
| No ventilation system | | 1 % |
| Room by room natural | | 4 % |
| Room by room mechanical | | 3 % |
| Overall natural | 3 % | 1 % |
| Overall mechanical | 98 % | 91 % |
| <i>Exhaust only without demand control of air flow rates</i> | 53 % | 54 % |
| <i>Exhaust only with demand control of air flow rates</i> | 44 % | 36 % |
| <i>Balanced systems</i> | 1 % | 2 % |

Table 3: Ventilation systems in residential buildings stock (source: AIR .H, 2007)

| | Multifamily buildings (13.1 millions dwellings) | One-family houses (17.3 millions) | Total dwellings stock (30.4 millions) |
|---------------------------|----------------------------------------------------|--------------------------------------|------------------------------------------|
| No ventilation system | 9 % | 14 % | 12 % |
| Room by room ventilation | 34 % | 36 % | 35 % |
| Overall ventilation | 57 % | 50 % | 53 % |
| <i>Overall natural</i> | 17.6 % | 22 % | 20 % |
| <i>Overall mechanical</i> | 39.5 % | 28 % | 33 % |

Table 5: Ventilation systems in commercial buildings stock (source: AIR .H, 2007)

| | Offices | Shops | Education buildings | Health care buildings | Leisure buildings | Hotels | Total |
|--------------------------------------------------------------|---------|-------|---------------------|-----------------------|-------------------|--------|--------|
| Stock (thousands square meters) | 3 026 | 3 732 | 1 747 | 1 700 | 1 666 | 821 | 12 692 |
| No ventilation system | 50 % | 40 % | 60 % | | 10 % | 5 % | 34 % |
| Overall natural | | | | | | 9 % | 1 % |
| Room by room mechanical | 10 % | 10 % | | 15 % | 20 % | | 10 % |
| Overall mechanical | 20 % | | 39 % | 50 % | | 85 % | 22 % |
| <i>Exhaust only without demand control of air flow rates</i> | 9 % | | 20 % | 25 % | | 75 % | 13 % |
| <i>Exhaust only with demand control of air flow rates</i> | 1 % | | | | | | 0.2 % |
| <i>Balanced systems</i> | 10 % | | 19 % | 25 % | | 10 % | 9 % |
| Air handling unit | 20 % | 50 % | 1 % | 35 % | 70 % | 1 % | 34 % |

Ventilation market France (source AIR. H. 2007, in F. Durier, 'Trends in the French building ventilation market and drivers for change', AIVC, VIP 19, May 2008).

4 Ventilation in multi-family residential sector

The diagrams below give an overview of the most important characteristics. They were calculated from data in the DG ENER Lot 1 preparatory study. Further statistics on buildings and heat loads can be found in Annex III. The reference year for the data in the diagrams is 2005 and the scope is EU-25. For the EU-27 a multiplier 1,06 will be used at a later stage. Note that there may be small deviations between the figures in the diagrams, due to definition problems.

The analysis for the EU-25 (2005) gives the following results:

106 mln. multi-family dwellings (44% of the residential sector), of which ca. 80% (84 mln.) are occupied, used permanently and equipped with a heating system (see fig. 16);

12,8 mln. multi-family buildings with a total floor area of ca. 9,1 bln. m², including dwellings at 65 m²/unit and a multiplier 1,25 for entrance, stairs, elevators, service area, indoor parking in a part of city apartments;

At an average floor height of 3 m (high share of older buildings), the built volume will be around 28 bln. m³, of this it is assumed that only the permanently occupied dwellings (heated and ventilated) are in the scope, representing 5,5 bln. m² and 16,4 bln. m³;

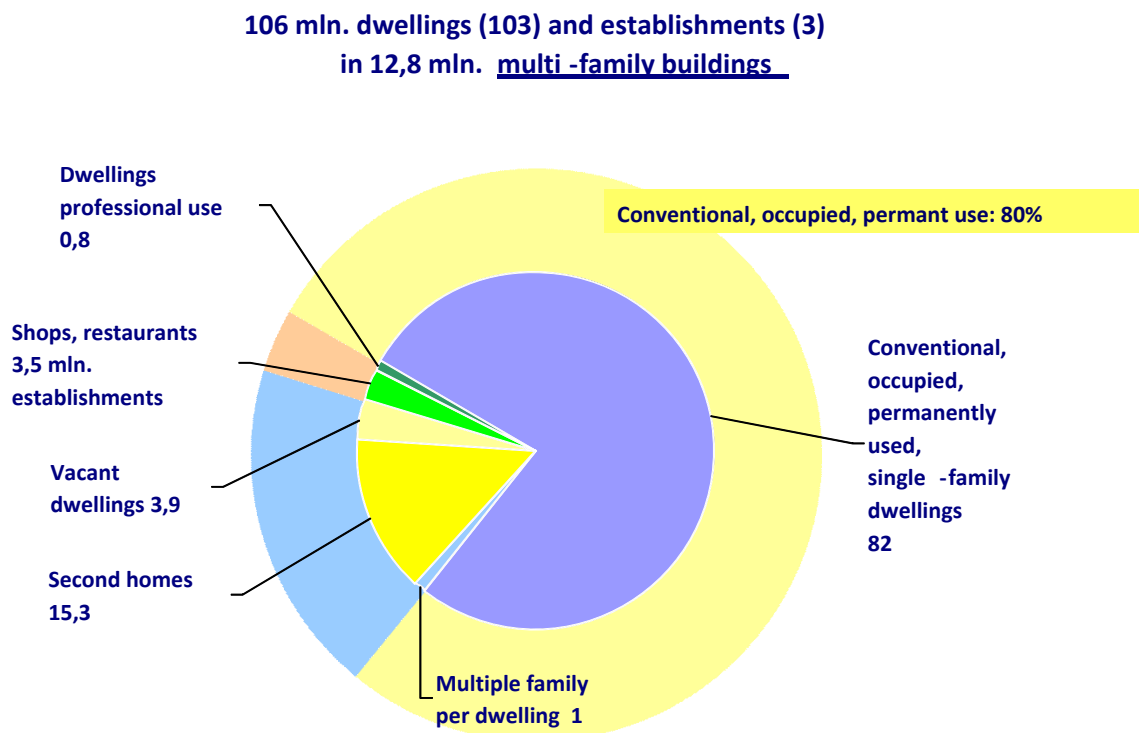


Fig. 19

Average EU -25 multi-family building: 8 flats/ building

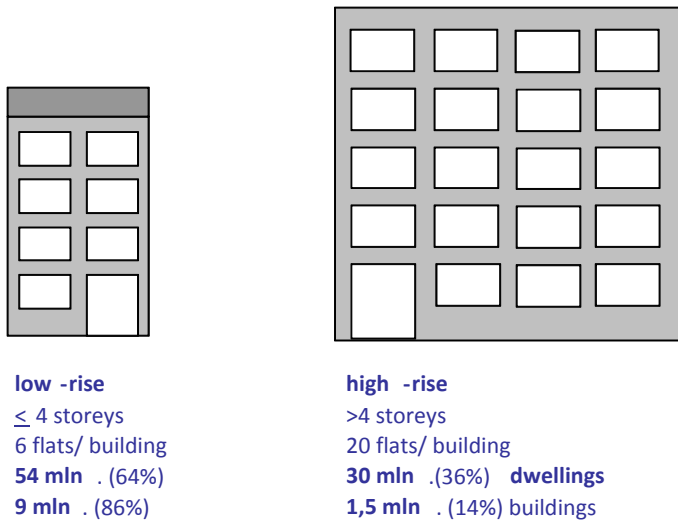


Fig. 20

64% of low-rise apartments (54 mln.; 10,5 bln. m³) are in 9 mln. buildings with 4 layers or less, i.e. typically city apartments with side-walls attached to a neighboring apartment. The AV ratio of the building will be 0,55 m²/m³. Per dwelling the ground- and top apartments will have a significantly higher AV-ratio (ca. 0,7) and the mid-apartments a lower AV-ratio (ca. 0,3).

70% of these low-rise apartments use natural ventilation (37,8 mln. dwellings; 7,35 bln. m³), 28% are using central mechanical exhaust ventilation (15,1 mln; 3 bln. m³) and 2% luxury apartments (1,1 mln.; 0,2 bln. m³) with a balanced mechanical ventilation system, possibly with cooling. Of this latter group half may have heat recovery (1%, 0,1 bln. m³).

36% of apartments (30 mln. dwelling; 5,9 bln. m³) are in 1,4 mln. buildings with 5 layers or more, i.e. typically peripheral flats. The AV ratio of the building will be 0,65 m²/m³. Per dwelling the corner, ground- and top apartments will have a significantly higher AV-ratio (ca. 0,7) and the mid-apartments a lower AV-ratio (ca. 0,3).

50% of these high-rise apartments use natural ventilation, with passive stacks for the wet rooms (15 mln.; 2,9 bln. m³) and 48% are using central mechanical exhaust ventilation, largely from retrofitting the passive stacks (14,4 mln.; 2,9 bln. m³). Again 2% luxury apartments (0,6 mln; 0,1 bln. m³) may have a balanced mechanical ventilation system, possibly with cooling. Of this latter group half may have heat recovery (0,3 mln.; 0,05 bln. m³).

To translate the above data into numbers of active installed ventilation equipment it is assumed that exhaust systems for the low-rise apartment buildings work vertically in a stack of 4 apartments with two exhaust openings (1 kitchen, 1 bathroom) per apartment. In practice this means 1 exhaust fan for every 2 dwellings. For balanced systems it means 1 balanced ventilation unit per 4 dwellings. For the high-rise buildings the stack is twice as high.

In total 52,8 mln. apartments are using natural ventilation, possibly (say 10%, 5 mln. units) with the help of a simple local extraction fan. The apartments with mechanical exhaust systems will use around 11 mln. rooftop/boxed fans, i.e. 7,6 mln. for low-rise and 3,6 mln. (with twice the average capacity) for high-rise buildings. Finally, around 0,35 mln. balanced

ventilation units (AHU or CHRV) will be installed in multi-family buildings. Note that these are the products that are permanently operational. If the total number of apartments is considered the numbers should be increased by 33%.

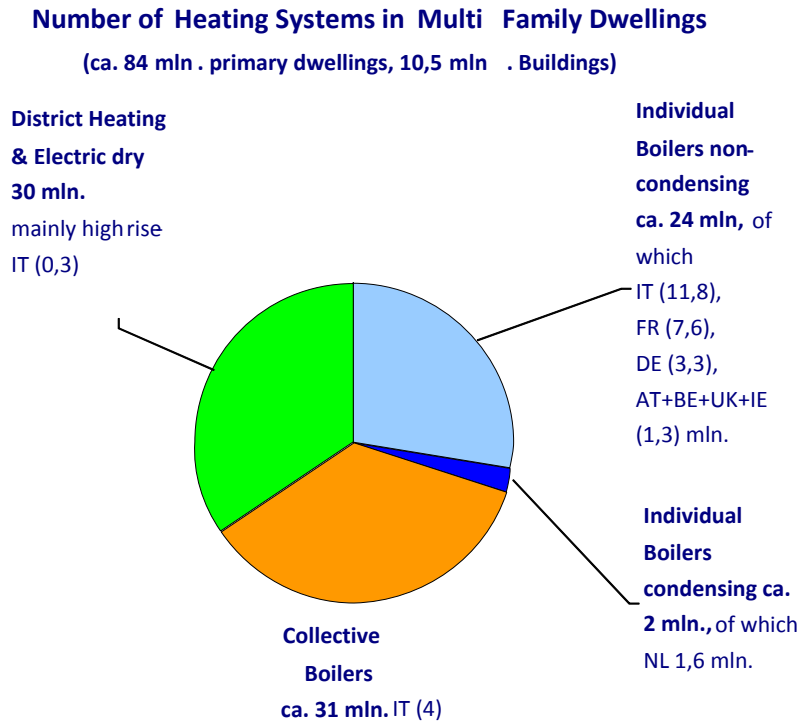


Fig. 21

5 Ventilation in (semi-) public sector buildings

5.1 Introduction

One of the sectors that should be a frontrunner in energy saving is the public sector. However, in the case of ventilation, let alone well controlled heat recovery ventilation, the government appears to be lagging behind. It is estimated that EU-wide only about 35% of schools (in terms of gross floor area) uses some sort of central mechanical ventilation. For other government buildings the market penetration is estimated to be no more than 15%. Overall market penetration of centralized ventilation in this sector is estimated at 20%. The other 80% uses natural ventilation (infiltration, windows).

Of this 20%, no more than 20-25% is believed to employ heat recovery modules. So the overall market penetration of 'good' ventilation practice is estimated at around 5%. In theory this means that there is a theoretical saving potential of 15% by retrofitting existing installations and around 65% through new installations. How much of this theoretical potential can be achieved in practice will depend –apart from appropriate measures and policies—on the technical limitations of the local infra-structure.

To express the current ventilation losses and future savings in terms of energy is no easy task. Data availability on buildings for public administration, education, health care and other community services is very poor, amongst others because the activities are very heterogeneous, fall under the responsibility of different departments in the various member states. Only about 40% of the buildings can be classified as typical "offices". All the rest are police stations, prisons, schools, archives, army camps, etc..

For those reasons desk research very often had to resort to national statistics and anecdotal sources, making the task 3 research for this sector much more labor-intensive and error-prone than for other sectors.

The following paragraphs describe, centered around a, how the estimates were made. Unless indicated differently in the text, an hourly air exchange of 1,2 m³/m³ is assumed. This reflects the high share of natural ventilation and infiltration.

The paragraphs are structured in accordance with typical government departments. The most important departments –health care, education, justice, home office & municipalities— are discussed in detail. The NACE subdivision, given in the table below for section L, was considered not to be very helpful as it often describes only the regulatory and policy part of the activities and not the executive side.

Table 2 .NACE rev. 1.1. L - Public administration and defence; compulsory social security

| | |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| 75.110 | General (Over-all) public service activities |
| 75.120 | Regulation of the activities of agencies that provide health care, education, cultural services and other social services excluding social security |
| 75.130 | Regulation of and contribution to more efficient operation of business |
| 75.140 | Ancillary service activities for the government as a whole |
| 75.210 | Foreign affairs |
| 75.220 | Defence activities |
| 75.230 | Public order and safety activities |
| 75.24 | Public security, law and order activities |
| 75.25 | Fire service activities |
| 75.300 | Compulsory social security activities |

5.2 Health care

The table below shows the number of health activities and the estimated ventilation losses in mln. m³/h.

Table 3. VHK Business & public sector statistics, section N - Health and social work (2005), EU-25

| Code | Description | Number | Totals | mln. m ³ /h @18°C |
|--------|---------------------------------------------------------|---------|----------------|------------------------------------|
| 85.111 | Hospital primary health activities | 5.949 | | |
| 85.112 | Hospitals for specialized somatic health activities | 2.732 | | |
| 85.113 | Hospitals for specialized psychiatric health activities | 833 | | |
| 85.114 | Rehabilitation centres | 13 | | |
| 85.115 | Other specialized health activities | 2.250 | | |
| | | | 11.777 | 993 |
| 85.121 | Medical practices, at hospitals | 161.804 | | |
| 85.122 | Medical practices, not at hospitals | 139.813 | | |
| 85.123 | Somatic polyclinics | 506.534 | | |
| 85.124 | Psychiatric healing centre | 19.333 | | |
| 85.125 | Adult psychiatric polyclinic | 10 | | |
| 85.127 | Childrens and adolescents psychiatric polyclinic | 11.314 | | |
| | | | 838.808 | 815 |
| 85.130 | Dental practices | 156.840 | | |
| | | | 156.840 | 189 |
| 85.141 | Medical laboratories etc. | 13.535 | | |
| 85.142 | Ambulance transports and ambulance health activities | 6.045 | | |
| 85.143 | Medical nursing homes | 45.341 | | |
| 85.144 | Other health establishments n.e.c. | 272.001 | | |

| | | | |
|--------------|----------------------------------------------------------|------------------|--------------|
| 85.145 | Organ collection centres and banks | 6 | |
| | | 336.928 | 2.028 |
| 85.200 | Veterinary clinics | 45.754 | |
| | | 45.754 | 55 |
| 85.311 | Service homes and homes for the aged | 6.128 | |
| 85.312 | Homes for disabled persons | 5.807 | |
| 85.313 | Homes for children and young people | 13.776 | |
| 85.315 | Homes for adult substance misusers | 2.786 | |
| 85.316 | Hostels etc. | 489 | |
| 85.322 | Child day-care establishments | 15.927 | |
| 85.323 | Social work establishments for children and young people | 1.533 | |
| 85.324 | Welfare and counselling centres | 10.097 | |
| 85.325 | Humanitarian relief organisations | 1.439 | |
| 85.327 | Day-care establishments for the aged | 3.836 | |
| 85.328 | Day-care establishments for disabled persons | 9.297 | |
| 85.329 | Day-care establishments for adult substance misusers | 1.998 | |
| | | 73.112 | 1.320 |
| TOTAL | | 1.463.219 | 5.400 |

The total is set at 5.400 mln. m³/h, not only due to the actual heated floor area, but also influenced by certain specific activities like laboratories, operating theatre and treatment areas that require up to 10 times the usual ventilation fold. These special activities are outside the scope of the study (see Annex III) but their effect on ventilation was taken into account here.

In the EU-27 (2006) there are 200.000 curative beds in hospitals (406,3 per 100.000 inhabitants) and 29.700 psychiatric care beds (60,4 per 100.000 inhabitants).²

5.3 Education

The table below shows the number of schools and institutions of vocational training, pertaining to NACE section M [code 80].

The number on universities require some extra explanation. In the EU there are approximately 550 larger universities with an average 170.000 m² gross floor area and 774.000 m³ volume officially named universities³. The rest are institutes of Higher Education

² Eurostat Yearbook 2009.

³ The Finance Minister of Baden-Württemberg (Drucksache 12 / 4784, 20. 01. 2000, Stromsparen in Landesgebäuden durch Modernisierung der Lüftungsanlagen ...) mentions 1,9 mln. m² for 1060 university buildings and 0,7 mln. m² for 340 university hospital buildings. Of this total of 2,6 mln. m² it is estimated that 910.00 m² (35%) has an air-conditioning or ventilation provision (Raum Luft Technische RLT Anlage). This is equivalent to around 530 buildings with an estimated 4 'RLT-Anlagen' per building. Overall electricity consumption was estimated at 38 GWh (taken as 0,53 x 72 GWh). In total around 15% of these installations were renovated in the last 5 years. The German district ('Land') Baden-Württemberg has 11 universities, so on average this is 172.000 m² per university. District inhabitants total ca. 10,8 mln., which is ca. 2% of EU-27. Other anecdotal evidence: Rotterdam Erasmus university 180.000 m² (20.000 students of law, economics, medicine). Gent

or comparable institutes (including around 250 small universities), assumed to have a gross floor area of around 20.000 m² and 90.000 m³ volume.

Table 4 . VHK Business & public sector statistics, section M - Health and social work (2005), EU-27

| Code | Description | Number | Totals | mln. m ³ /h @18°C |
|-------------------|-------------------------------------------------------------------------------|--------|----------------|------------------------------|
| 80.101 | Pre-primary school education | 39.999 | | |
| 80.102 | Compulsory comprehensive school education and pre-school class | 8.682 | | |
| 80.103 | Special school primary education | 192 | | |
| | | | 48.873 | 1100 |
| 80.211 | General secondary education | 1.063 | | |
| 80.212 | General secondary education | 12.418 | | |
| 80.221- 80.223 | General secondary education and technical and vocational secondary education | 19.979 | | |
| | | | 33.460 | 1150 |
| 80.301 | University (ca. 500-600) and university college higher education (ca. 10.500) | 11.235 | | |
| 80.303 | Military higher education | 1.389 | | |
| 80.309 | Other higher education | 557 | | |
| | | | 13.181 | 1415 |
| 80.410 | Driving schools | 40.153 | | |
| 80.421 | Municipal adult education | 917 | | |
| 80.422 | Labour market training | 2.724 | | |
| 80.423 | Folk high schools | 458 | | |
| 80.424 | Adult education associations | 2.190 | | |
| 80.425 | Staff training | 73.021 | | |
| 80.426 | Municipal culture schools | 229 | | |
| 80.427 | Educational service | 98.176 | | |
| 80.429 | Other education | 50.660 | | |
| | | | 268.527 | 310 |
| | TOTAL | | 364.042 | 3.960 |

In the EU-27 (2006) there were 93,9 mln. people enrolled in school (excluding pre-school), of which 28,5 mln. in primary school (ISCED 1), 22,9 mln. in lower secondary school (ISCED 2), 23,6 mln. in upper secondary and post-secondary non-tertiary school (ISCED 3 and 4) and 18,8 mln. in tertiary education (ISCED 5 and 6).⁴

Minimum gross floor area building standards per pupil/student (derived from NL and checked against anecdotal evidence from other EU countries) are 3,5-4 m² for primary schools, 7-8 m² for secondary schools and on average 9 m² for university. For ISCED levels 4 to 6, the ratio depends highly on the direction, e.g. as low as 5 m² per law-student and up to 40 m² per engineering student.

university real estate 771 buildings and 750.000 m² total. Leiden University has 70 buildings with 222.000 m² floor area. Extreme cases are universities specialized in law, economics with much less m² per student and there are technical universities with much more than average m² per student. E.g. Delft technical university has around 450.000 m² gross floor area (12.000 students).

⁴ Eurostat Yearbook 2009.

On the other hand, anecdotal evidence suggests that the floor area per pupil may also be as high as 17-20 m² for primary schools⁵ and 40 m² for tertiary (technical) education.

Average floor height is assumed to be 4,5 m. The total heated floor area is 880 km² and the volume is **3960 mln. m³**.

Apart from the institutions mentioned in section M, Ministry of Education has extra costs for subjects dealing with research and culture, e.g.

- national research laboratories (3,6 mln. m² floor area, but at high ventilation fold estimated at **50 mln. m³/h** at 18oC), mainly classified under section K (code 73).
- core central ministry, classified under NACE section O (code 75), accounting for 4 mln. m² or **16 mln. m³**.
- national museums, classified under NACE section O (code 92.520) and not taken into account here
- university clinics, classified under 'Health care', NACE section N (code 85.111) and not taken into account here.

In total, educational activities account for around 900 mln. m² heated floor area and the equivalent of **4000 mln. m³** heated volume.

5.4 Justice

The **EU Justice departments** occupy a relatively large heated gross floor area. It is estimated that they occupy around 75-80 mln. m², which equals ca. **350-370 mln. m³** of heated volume. The estimated split-up of this figure is as follows:

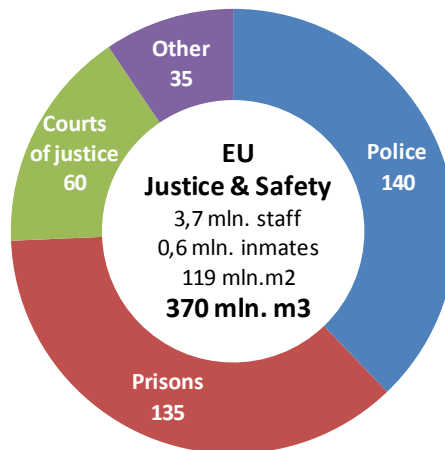


Fig. 22

⁵ Example Germany: model 'Passiv' school: 8700 m², 40.347 m³ for 400 primary school and 100-125 kindergarten, 50 staff. Heat recovery ventilation at a rate of 21.700 m³/h.

Eurostat reports that in 2006 the EU-27 **police**-force consists of 1,7 mln. police officers⁶. From national statistics it is estimated that the police force is supported by around 1 mln. technical and administrative staff and trainees.⁷ In most countries police efforts are split between justice and defense department, but for the sake of clarity the 0,25-0,3 mln. paramilitary forces working as border police, coast guard and customs guards are classified as 'police' and have to be added to the 1,7 mln. staff reported by Eurostat. Statistics on heated gross floor area of buildings are scarce, but from anecdotal evidence a figure of 10 m² per person is estimated.⁸ At around 3 mln. personnel this brings the total heated floor area to approximately 30 mln. m² and a volume of around **110 mln. m³**. An archetype police station (small city) has around 800-1000 m² heated floor area. Building sizes ranges from <100 m² (small village) to >25.000 m² (regional head office or larger city).

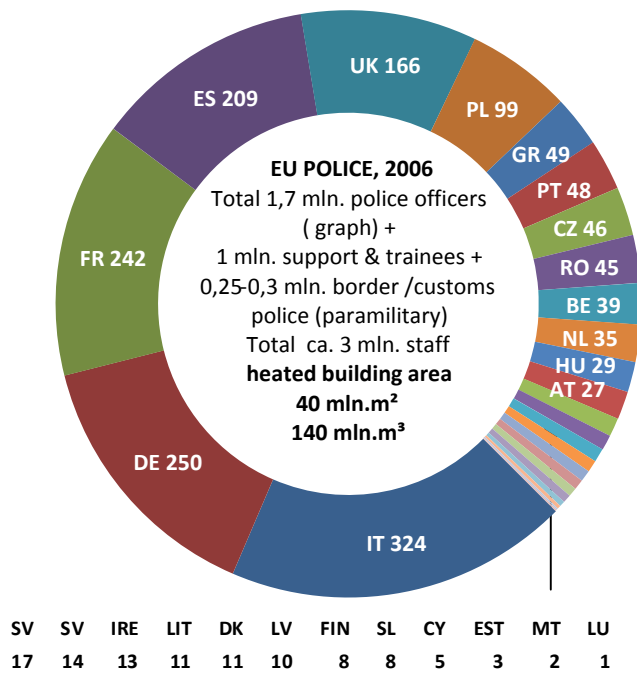


Fig. 23

Courts of justice are the working place of around 50-60.000 judges and 120-150.000 other staff⁹. Gross floor area can be derived directly from central government statistics and will be around 15 mln. m², which results in around **60 mln. m³**.¹⁰

The EU-27 has around 0,6 mln. **prisoners**¹¹ and 0,28 mln. direct prison personnel.¹² Gross floor area per EU prisoner is around 70 m² for smaller prisons (<500 inmates)¹³, 56 m² for

⁶ Eurostat 2009, crim_plce

⁷ Ministry of the Interior NL, Kerngegevens personeel Overheid en Onderwijs 2008, The Hague 2009. Police officers 35.972 (equals Eurostat data), support staff 20.042, trainees 6.232. Total 62.246 police staff.

⁸ Netherlands has 15% state police (military police (6800 staff), national police force KLPD (5000 staff)) and 85% regional police. State police (RGD 2009) takes up 85.959 m² (ca. 5400 officers).

⁹ NL: 800 public defenders in NL (source: Chairman of the NL 'College van procureurs-generaal', Harm Brouwer, 22.11.2009, programme Buitenhof). EU=NLx30→ 24.000. Note that in some countries the denominations 'judge' and 'public defender' may be used differently.

¹⁰ RGD Jaarverslag 2009: Courts of Justice NL 2009: 535.551 m² for ca. 4000 staff (ibid. 10) . In 2000 there were around 1700 judges in the Netherlands.

¹¹ Eurostat 2009, crim_prsn

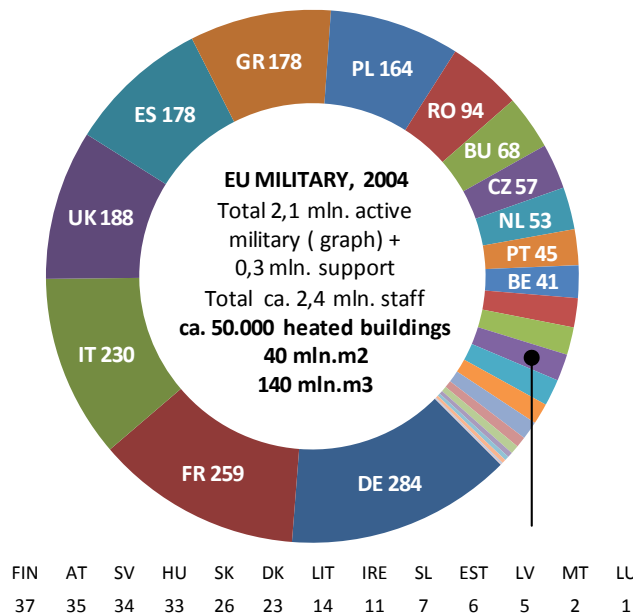
¹² CBS, Netherlands: 17.600 prisoners (2005), 9.447 direct prison personnel (on a total of 17.558 full time personnel for all types of penitentiary institutions).

medium sized prisons (500-1000 inmates) and 36 m² for large prisons (>1000)¹⁴. At 56 m² per inmate the prison floor area is 33,6 mln. m² and at a floor height of 4 m the total volume is **135 mln. m³**.

Other personnel on the Justice department budgets involves general management and policy (100.000 staff¹⁵), immigration service (100.000 staff), state bailiffs service (25.000 staff), national forensics labs¹⁶ (20.000 staff, 9 mln. m³), ICT and other support (15.000). ¹⁷ The ventilation need is estimated at around **30 mln. m³**.

5.5 Defense

The EU Defense departments employs around 2,1 mln. active military staff ¹⁸ (2004), with around 15% (300.000) civilian support staff. The number of reservists varies widely per country, but they are not estimated to take up heated floor area (training facilities partitioned to active military staff). Para-military forces are not included under this heading, but included under the heading 'police'. Total headcount of employees under the heading 'Defense' is thus estimated at 2,4 mln. For the heated gross floor area only anecdotal were found, but is estimated at around 15 m² per person.¹⁹ This results in 40 mln. m² floor area and an estimated **140 mln. m³** of heated volume. ²⁰ Note that this is 0,15% of the EU total, i.e. considerably less than the 0,7% estimated in the diagram.



¹³ Typical for NL: RGD Jaarverslag mention s 1.265.460 m² for penitentiary institutions

¹⁴ Nawal Al-Hosany, Energy Management and Façade Design in Prison Buildings in Hot Climates: The Case Of Abu Dhabi, Research Paper, 2000.

¹⁵ RGD: Core departments 625.206 m² for 13 departments → ca. 50.000 m² per department.

¹⁶ NFI, the Dutch Forensics Lab, employs 350 staff (+200 at central level), 28.000 m², volume ca. 100.000 m³, but very high ventilation need at 300.000 m³/h (3 m³/h).

¹⁷ NL: Immigration 3392, bailiffs ('deurwaarders') 880, forensics 580, ICT and Justis 389.

¹⁸ Active military staff: Wikipedia.nl. Ratio civilians/military taken from ibid. 11.

¹⁹ Netherlands (53.150 military) occupies 47 army bases (Wikipedia). Gross floor area of buildings is around 25.000-40.000 m². Part of this will be unheated. Estimated is 15.000 m² of heated floor area for around 1000 personnel.

²⁰ Netherlands (professional army only): 67.000 personnel, 85.496 m² gross floor area. In countries with drafted personnel specific floor area is believed to be factor 2 higher.

Fig. 24

5.6 Home office and municipalities

The core department of the Home Office (a.k.a. 'Ministry of Internal Affairs') is estimated to account for around 4 mln. m² (**16 mln. m³**). But more importantly, the Home Office in many countries has the prime responsibility for the regional and local government, i.e. the 'municipalities'.

In the EU around 6 mln. civil servants are working at regional and municipal level. Apart from the regulatory and policy activities, these jobs include municipal personnel for waste collection, public transport (often privatized), museums, libraries, archives, municipal health services (e.g. ambulances etc.), secretarial services and administration. At an average of 20 m² per employee (80 m³/employee) this results in an extra 480 mln. m³, bringing the total to **500 mln. m³**. Below two sectors, fire & rescue services and the waste collection and disposal are highlighted.

Fire & rescue services are mentioned as a separate NACE group, but statistics on the EU-27 fire & rescue services are relatively poor. The EU-27 has probably around a few million registered fire fighters, but only around 130-150.000 of those are professionals. The others are pure volunteers and on 'Retained Duty Service' ("on-call"). Numbers and organizations differ between countries, based on national customs and geography.²¹ The buildings of the fire brigades are mainly unheated garages and do not contribute to the heated gross floor area. The estimate in the table is based primarily on a number of 150.000 professional firemen and a heated gross floor area of 20 m²/employee. This gives 3 mln. m² heated floor area and –at a floor height of 4,5 m, around 13,5 mln. m³ of heated volume. In order also to take into account the heating of training and meeting facilities of the voluntary brigades this latter figure was rounded to **20 mln. m³**.

Another activity that is often part municipal and part private is the waste disposal. The table below gives an overview.

Table 5. VHK Business & public sector statistics, section O - Other community activities (2005), EU-27

| Code | Description | Number | Totals | mln. m ³ /h @18°C |
|--------|-----------------------------------------------|--------|--------|------------------------------------|
| 90.001 | Sewage collection and -treatment | 38.787 | | |
| 90.021 | Collection and sorting of non-hazardous waste | 86.261 | | |

²¹ A country like Austria boasts as much as 312.897 registered firemen, but out of the 4.894 fire brigades only 6 are professional, 333 are private company fire brigades and as much as 4.555 voluntary brigades. On the other side of the spectrum the Netherlands reports 500 fire brigades and 27.000 firemen, of which as much as 4500 are professionals and 22.500 are volunteers. In Germany, the Feuerwehr is organized in 33.000 locations with around 1,3 million firemen. The UK and Belgium organize their Fire & Rescue Services at regional level. E.g. Wales reports 151 Fire and Rescue stations and 1978 firemen, of which most volunteers. The Flanders (BE) professional association reports 12.000 members, of which 25% professionals and 75% volunteers.

| | | | |
|--------|----------------------------------------------------------------|----------------|------------------|
| | Plants for composting and anaerobic digestion of non-hazardous | | |
| 90.022 | waste | 2.783 | |
| 90.023 | Depots for non-hazardous waste | 6.758 | |
| 90.024 | Handling and interim storage of hazardous waste | 9.938 | |
| 90.025 | Treatment plants and final depots of hazardous waste | 5.963 | |
| 90.026 | Other refuse disposal plants | 27.366 | |
| 90.030 | Street cleaning and other sanitation establ. | <u>185.685</u> | |
| total | | | 363.540 148 |

It is estimated that around 0,7 mln. workers are engaged in NACE code 90. NACE code 90.030 (street cleaning activities) was not taken into account for the calculation of the ventilation requirement. In recent years private companies have started to become the major employer in this activity.

5.7 Other public buildings

The Finance department involves around 1 mln. tax office & customs staff and 100-200.000 central staff. Total gross floor area is estimated at 30 mln. m², resulting in **110 mln. m³**.

The ministry of Transport, co-ordinates building and maintenance of highways, bridges, waterways, etc. usually by hiring 3rd parties, but also by state agencies (**40 mln. m³** extra).

Foreign Affairs runs embassies and consulates (**24 mln. m³** extra). The Ministry of Social Affairs has extra personnel in the form of around 600.000 staff for the Social Service²² (**35 mln. m³** extra)

International organizations are estimated to employ around 0,1 mln. people. Given the need for meeting space, the average floor area per employee is estimated at 44 m². At a floor height of 4 m this results in about **18 mln. m³**.

On top of the above, each department occupies around 4 mln. m² (16 mln. m³). For e.g. the PM office this is the only item on the balance.

5.8 Public sector summary

The total ventilation of public sector, health care and education buildings is estimated at 11.100 m³/m³.h. The diagram below gives the breakdown of this figure.

²² Kerngegevens: Zelfstandig Bestuursorgaan for Dutch Ministry of Social Affairs: 19.899 staff (2008)

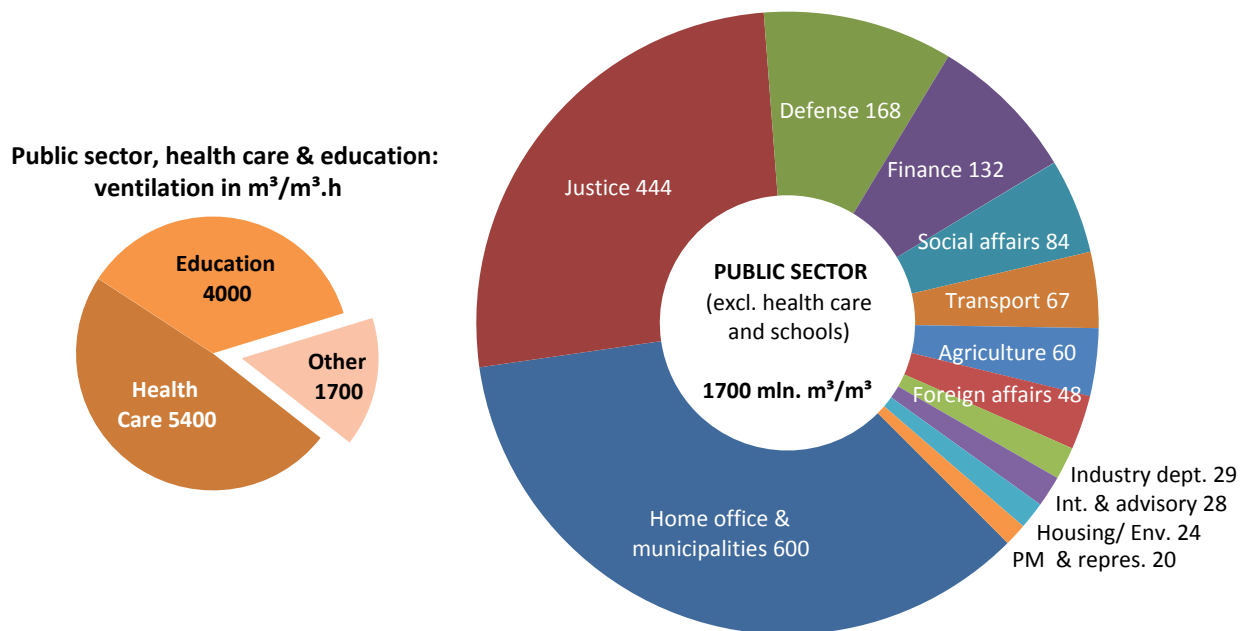


Fig. 25

The ventilation and infiltration during the heating season (5000 h) is 55.500 bln. m³. The ventilation heating energy loss, at an indoor-outdoor temperature difference of 9 degrees, is

$$55,5 \times 1012 \times 9K \times 0,33 \text{ Wh/m}^3.K = 165 \text{ TWh}$$

where 0,33 Wh/m³.K is the specific heat capacity of air.

At a heating system efficiency average of 60% this results in a fuel consumption (primary energy, Gross Calorific Value of fuel) of 275 TWh or 993 PJ per year. Assuming natural gas to be the predominant heating fuel type this amounts to carbon emissions of 57 Mt CO₂ equivalent per year.

Assuming that

- 0,25 m³/m³.h of infiltration losses will be inevitable (20%),
- of the existing installations (20% of total) only 70% can be upgraded (missing 5%),
- of the buildings without centralized ventilation around 25% cannot be equipped with centralized ventilation for reasons of infrastructure (missing 25%),

the practical saving potential is estimated at around 50% of 57 Mt CO₂ equivalent, or rather around 28 Mt CO₂ equivalent per year. In terms of energy this equals 135 TWh or close to 490 PJ per year.

This does not take into account the effect on the cooling energy in summer, which may add some 30-50% to the potential depending on the location.

5.9 Social, culture and entertainment, sports activities [NACE O]

5.9.1 Overview

Section O of the NACE statistics contains an overview of organizations in social, communication, entertainment and sports activities. Both national and Eurostat statistics on this section are notoriously unreliable: Definitions are not well defined, several activities are mixed between private and public and a great number of organizations are working with volunteers and overall the registration practice is poor.

Nevertheless, VHK has pulled together the best available statistics and additional information in order to give an estimate of building stock and volume. The tables are taken from the VHK Business & Public Sector Statistics project.

5.9.2 Political and religious organizations

Table 6. Political and religious organisations, NACE section O (code 91) - Other community activities (EU 2005)

| | | | | |
|--------|---------------------------------------------------|---------|---------|-------|
| 91.111 | Business organizations | 34.167 | | |
| 91.112 | Employers organizations | 3.579 | | |
| 91.120 | Professional organizations | 4.194 | | |
| 91.200 | Trade unions | 6.296 | | |
| 91.310 | Religious congregations (11.265, figure=churches) | 200.000 | | |
| 91.320 | Activities of political organizations | 131.295 | | |
| | total | | 190.795 | 1.136 |

Even though the statistics offices register only a limited number of 11.000 'religious congregations', the church statistics show that there are around 150-200.000 ecclesiastical buildings (churches)²³. There are no exact data on size, but it is estimated that an average church will have a volume of at least around 20.000 m³ (e.g. 35 x 70 x 8 m). Their total volume will be at least some 4000 mln. m³. Even if they are heated to a temperature well below 18 °C and only at times of mass, weddings, etc., it is estimated that the hourly air change amounts to **1000 mln. m³/h** during the time that the heating is on. To this the heating of convents has to be added. In total the ventilation losses will amount to around 1% of the EU-27 total.

²³ NL: around 2500 catholic churches, 450 mosques, 3-4000 protestant churches.

5.9.3 Entertainment and news

Table 7 . Entertainment & news, NACE section O (code 92.1-92.4) - Other community activities (EU 2005)

| | | | | |
|--------|-----------------------------------------------------------------|---------|----------------|--------------|
| 92.110 | Video and movie production for televisions | 12.410 | | |
| 921B | Institutional and promotional movie production | 23.251 | | |
| 921C | Production of movies for the movie theatre | 25.451 | | |
| 921D | Technical service for the movie theatre and television | 11.051 | | |
| 92.121 | Motion picture distribution | 1.687 | | |
| 92.122 | Video distribution | 3.730 | | |
| 92.130 | Motion picture projection | 5.585 | | |
| | | | 83.165 | 899 |
| 92.201 | Production of radio programs | 9.861 | | |
| 92.202 | Production of television programs | 9.861 | | |
| 92.203 | Editing of general channels | 266 | | |
| 92.204 | Editing of thematic channels | 2.079 | | |
| 92.205 | Distribution of program clusters for radio and television | 965 | | |
| | | | 23.032 | 476 |
| 92.310 | Performing artists and producers of artistic and literary works | 391.691 | | |
| 92.320 | Theatre and concert hall co etc. | 16.069 | | |
| 92.330 | Fairs and amusement parks | 11.067 | | |
| 92.341 | Dancing and other entertainment establ. | 7.802 | | |
| 92.342 | Dancing and other entertainment establ. | 7.989 | | |
| 92.343 | Dancing and other entertainment establ. | 4.296 | | |
| 92.344 | Dancing and other entertainment establ. | 10.642 | | |
| | | | 449.556 | 1.594 |
| 92.400 | News agencies | 37.355 | | |
| | | | 37.355 | 84 |
| | TOTAL 92.1-92.4 | | 593.108 | 3.053 |

Note that the publishers and printers of books, magazines and newspapers are not included here, because it is represented by NACE section D (manufacturing), code 22.

Furthermore, note that 'dancing and other entertainment establishments' are listed under NACE 92.341, but that discotheques are listed as a retail activity.

Finally, it should be noted that the NACE classification places 'Personal services' such as hairdressers, funeral homes in the underlying section O, whereas this study classifies them in the

5.9.4 Other cultural/ educational activities

Museums and libraries were already mentioned as part of the public sector activities, but in fact many of these activities are also private or semi-public, at best co-financed by the public sector at either national, regional or municipal level. For that reason, the table below on NACE section 92.5 at least provides some further insight.

Table 8 . Libraries, museums and zoo's, NACE section O (code 92.5) - Other community activities (EU 2005)

| | | | | |
|--------|-------------------------------------------------------------|-------|---------------|------------|
| 92.510 | Library and archives activities | 6.227 | | |
| | museums activities and preservation of historical sites and | | | |
| 92.520 | buildings | 7.422 | | |
| 92.530 | Botanical and zoological gardens and nature reserves | 2.261 | | |
| | TOTAL 92.5 | | 15.910 | 263 |

5.9.5 Sports facilities

Table 9. Sports and related activities, NACE section O (code 92.6-92.7) - Other community activities (EU 2005)

| | | | | |
|------------------------|--------------------------------------------------|---------|----------------|--------------|
| 92.611 | Ski facilities | 1.764 | | |
| 92.612 | Golf courses | 8.134 | | |
| 92.613 | Motor racing tracks | 2.295 | | |
| 92.614 | Horse race tracks | 3.197 | | |
| 92.615 | Arenas, stadiums and other sports facilities | 14.688 | | |
| 92.621 | Sportsmen and sports clubs | 32.284 | | |
| 92.622 | Horse racing stables | 112.042 | | |
| 92.623 | Sports schools, boat clubs, etc. | 14.927 | | |
| 92.624 | Sports events organizers | 13.118 | | |
| 92.625 | Sports activities administrators | 835 | | |
| | | | 203.286 | 868 |
| 92.710 | Gambling and betting companies (incl. lotteries) | 17.506 | | |
| 92.721 | Riding schools and stables | 56.374 | | |
| 92.729 | Various other recreational establishments | 129.844 | | |
| | | | 203.724 | 778 |
| TOTAL 92.6-92.7 | | | 407.010 | 1.646 |

The estimate of **1646 mln. m³** heated volume in the VHK Business & public sector statistics, based on official statistics appears to focus on sports activities where a considerable amount of money is involved, but hardly on municipal facilities for non-profit sports clubs. From the buildings and heating perspective this is incorrect.

The number of indoor swimming pools is 1 per 50.000 inhabitants in Western Europe, 1 per 300.000 inhabitants in Eastern Europe. Overall in the EU-27 this means around 5.000 indoor swimming pools, with a surface of at least 12.250 m³ (25 x 35 x 10 m), up to 37.500 m³ (50 x 50 x 15). At an average 20.000 m³ per pool this means 100 mln. m³. But the average temperature is high, as is the ventilation effort. Around **200 mln. m³/h** is estimated.

The EU has at least 500 larger indoor sports arena's with an average capacity of 9.000 seats. (15.000 m³ x 20 m = 300.000 m³). Indoor speed-skating halls (400 m tracks) are small in numbers but large in volume: There are an estimated 20 in the EU. At around 0,25 mln. m³ per hall this results in 5 mln. m³. In total the volume of the larger indoor sports arena's is estimated at **155 mln. m³**.

Finally, it is estimated that around 150.000 public (municipal) indoor sports courts (at 30 x 15 x 8m = 3600 m³ per court) outside of the ones in schools. This results in a heated volume of **540 mln. m³**.²⁴

In total, excluding the facilities in educational institutions, the ventilation need in sports facilities is estimated at **2541 mln. m³**. Note that this is considerably less than the 3,2 % (3.520 mln. m³) estimated in figure 1.

²⁴ Example Ahoy (tennis): 30.000 m² x 20 = 600.000 m³ x 30 → 18 mln. m³.

6 Service sector

6.1 Introduction

The table below gives the Eurostat overview of added value and employment in the service sector (excluding financial institutions). TWith an added value of close to € 3000 bln. the sector resrepresents around 28% of EU-27 GDP and 35% of employment in the active workforce.

Table 10. EU-27 Service sector 2005 (source Eurostat, SBS)

| | Value added | | Employment | |
|--------------------------------------------------------------------|-------------|--------|------------|--------|
| | EUR billion | | x1000 | |
| Services (G to I and K) TOTAL | 2.991,3 | 100,0% | 76.133,0 | 100,0% |
| Distributive trades (G) | 1.022,4 | 34,2% | 30.963,9 | 40,7% |
| Sale, maintenance/repair of motor vehicles (G50) | 150,9 | 5,0% | 4.106,7 | 5,4% |
| Wholesale/commission trade, exc. for motor (-cycles) (G51) | 479,7 | 16,0% | 9.732,4 | 12,8% |
| Retail trade (exc. motor vehicles), repair of personal goods (G52) | 391,8 | 13,1% | 17.124,8 | 22,5% |
| Hotels and restaurants (H) | 167,8 | 5,6% | 8.845,9 | 11,6% |
| Transport and communications (I) | 629,9 | 21,1% | 11.823,7 | 15,5% |
| Land transport, transport via pipelines (I60) | 180,0 | 6,0% | 5.500,0 | 7,2% |
| Water transport (I61) | 25,0 | 0,8% | 213,5 | 0,3% |
| Air transport (I62) | 27,2 | 0,9% | 400,0 | 0,5% |
| Supporting transport activities, travel agencies (I63) | 147,9 | 4,9% | 2.612,1 | 3,4% |
| Post and telecommunications (I64) | 250,9 | 8,4% | 3.075,2 | 4,0% |
| Real estate, renting & business activities (K) | 1.171,2 | 39,2% | 24.499,5 | 32,2% |
| Real estate activities (K70) | 248,0 | 8,3% | 2.690,0 | 3,5% |
| Renting of machinery, and of pers. & househ. goods (K71) | 75,0 | 2,5% | 600,0 | 0,8% |
| Computer and related activities (K72) | 170,0 | 5,7% | 2.700,0 | 3,5% |
| Research and development (K73) | 21,8 | 0,7% | 400,0 | 0,5% |
| Other business activities (K74) | 655,5 | 21,9% | 18.102,4 | 23,8% |

6.2 Distributive trade and personal services

The diagrams below are an extract from the VHK Business & Public Sector Statistics project. More detailed split-ups at NACE 5-digit level are given in Annex I.

The diagrams show the number of companies and the estimated hourly ventilation rate for the retail sector [NACE section H, code 52], personal services [NACE section O, code 93], wholesale [NACE section H, code 51] and the trade in motor vehicles [NACE section H, code 50].

A more detailed breakdown of the company count at NACE 5-digit level is given in Annex I.

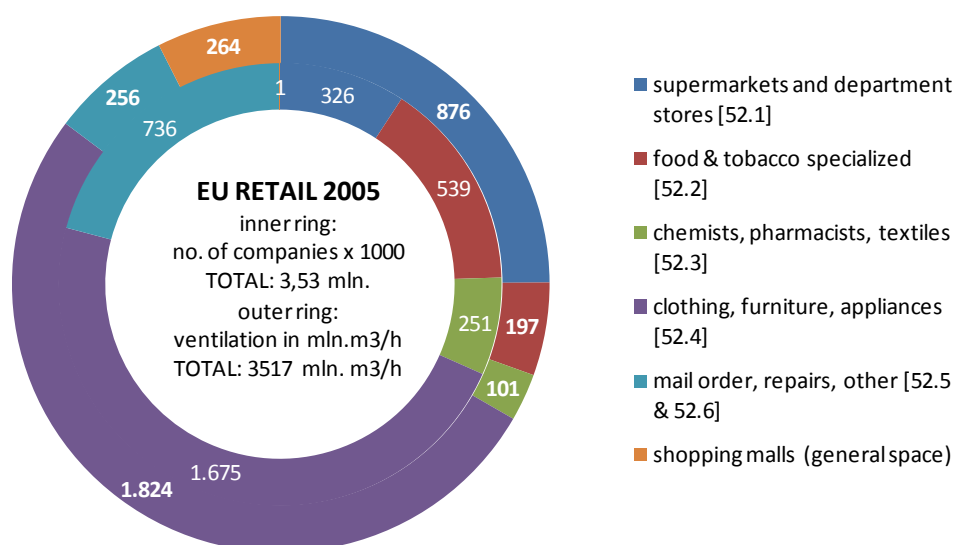


Fig. 26

Table 11. VHK Business & public sector statistics, section O. Personal Services (2005), EU-27

| Code | Description | Number | Totals | mln. m³/h @18°C |
|--------|--------------------------------------------------------------|---------|---------|--------------------|
| 93.011 | Laundries and drycleaning establ. for businesses and instit. | 3.805 | | |
| 93.012 | Laundries and drycleaning establ. for households | 62.595 | | |
| 93.021 | Hairdressers | 353.193 | | |
| 93.022 | Beauty parlours | 158.709 | | |
| 93.023 | Care for the defunct | 20.794 | | |
| 93.030 | Undertakers etc. | 16.599 | | |
| 93.041 | Physical well-being establishments - hot baths and spas | 10.708 | | |
| 93.042 | Other physical well-being establishments | 72.302 | | |
| 93.050 | Other service establishments n.e.c. | 146.058 | | |
| total | | | 844.762 | 466 |

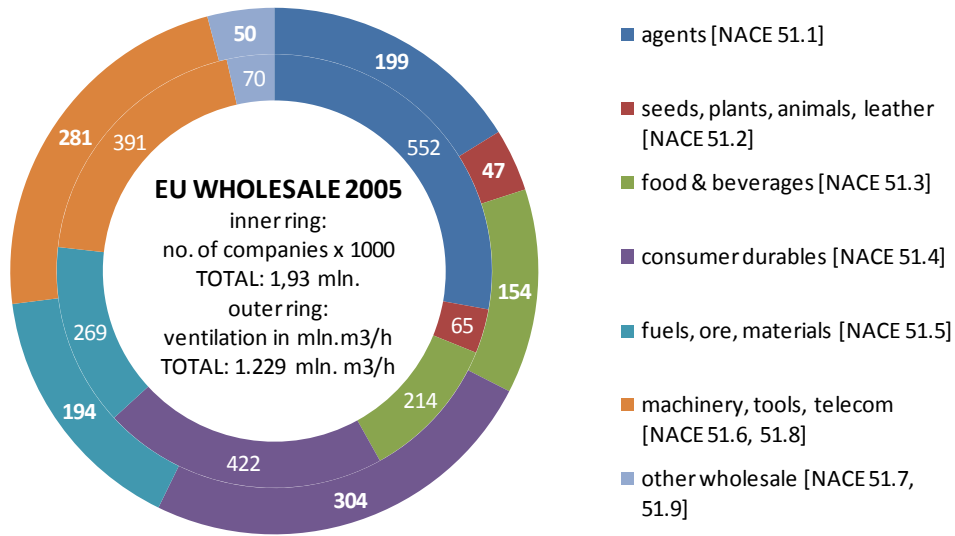


Fig. 27

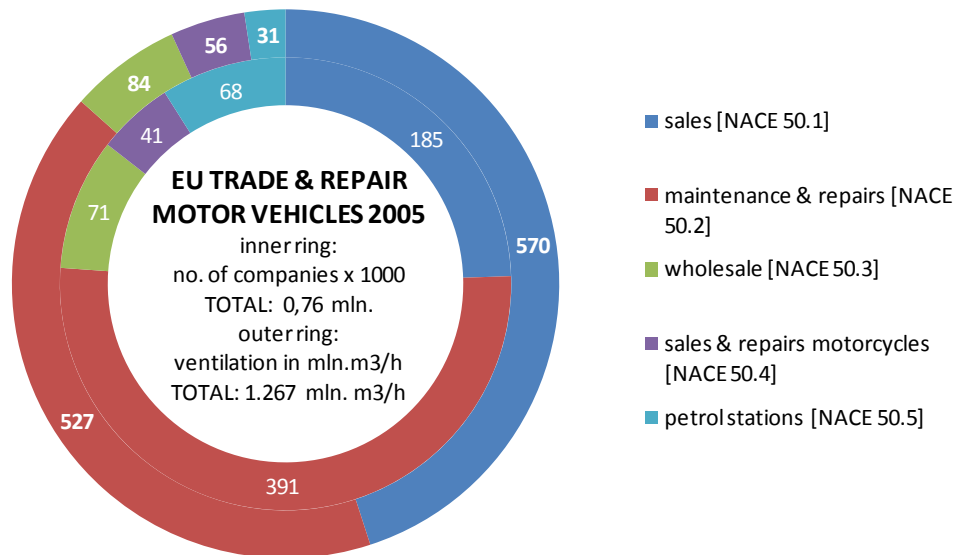


Fig. 28

It is estimated that retail and personal services (total 4,37 mln. companies) account for a ventilation need of around 4.000 mln. m³/h@18°C. of heated floor space.

There is a trend towards more (indoor) shopping malls in the EU. In 2005, the Retail Consulting Group, already predicted 150 m²/1000 inhabitants. Today, this may be around 200 m²/1000 inhabitants. At a typical size of 100.000 m² per mall this means 2 large malls per mln. inhabitants or rather around 1000 large shopping malls in Europe. This represents the equivalent of 100 mln. m². Every mall holds around 100-150 retail outlets, already taken into account above and representing one third of the volume, but it still means that 66 mln. m² (**264 mln. m³**) is unaccounted for, which has to be added to the above total.

This brings the retail total to around **4264 mln. m³**. Including wholesale and trade in motor vehicles the total becomes **6760 m³**. This is 6,1% of total, which is much more than the estimated 4% in figure 1.

6.3 Hotels & Restaurants

Eurostat (2006) reports for the EU-27 a (2003) ncapacity of in total 25 mln. beds/places, subdivided between 11 mln. hotel beds, 9 mln. places on tourist camp-sites, 2,5 mln. holiday dwellings and 2,2 other collective accommodations.

The count of the number of enterprises and an estimate of the floor area is given in the graph below

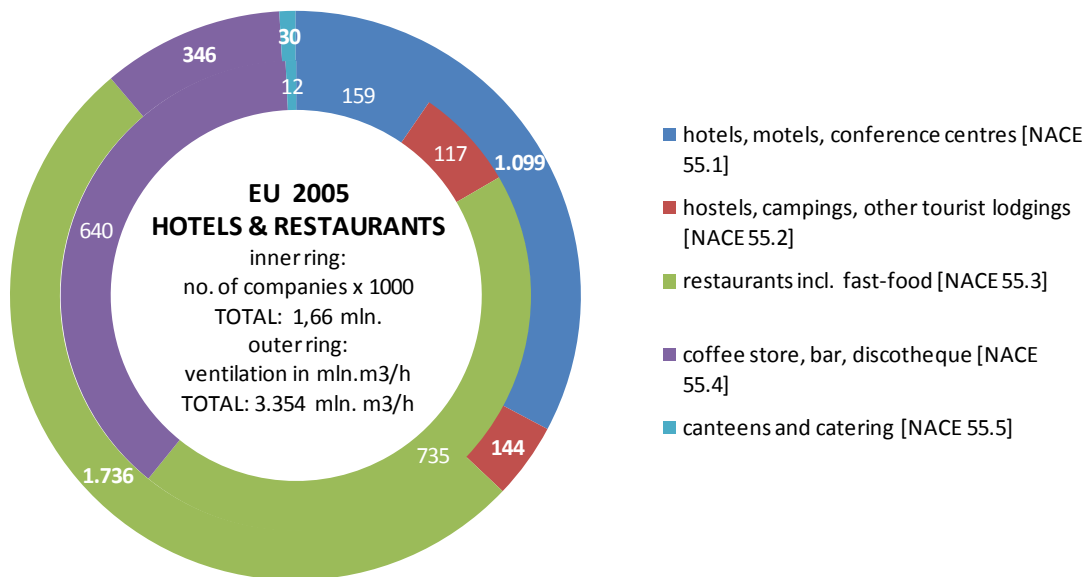


Fig. 29

6.4 Business services, real estate and rental companies

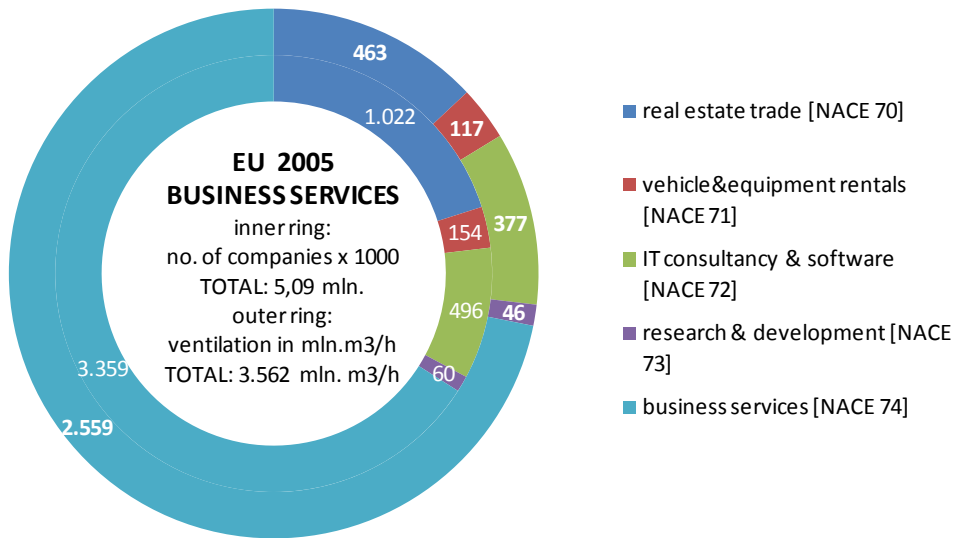


Fig. 30

EU-27 Business services: Number of Companies (total 3,359 mln.)

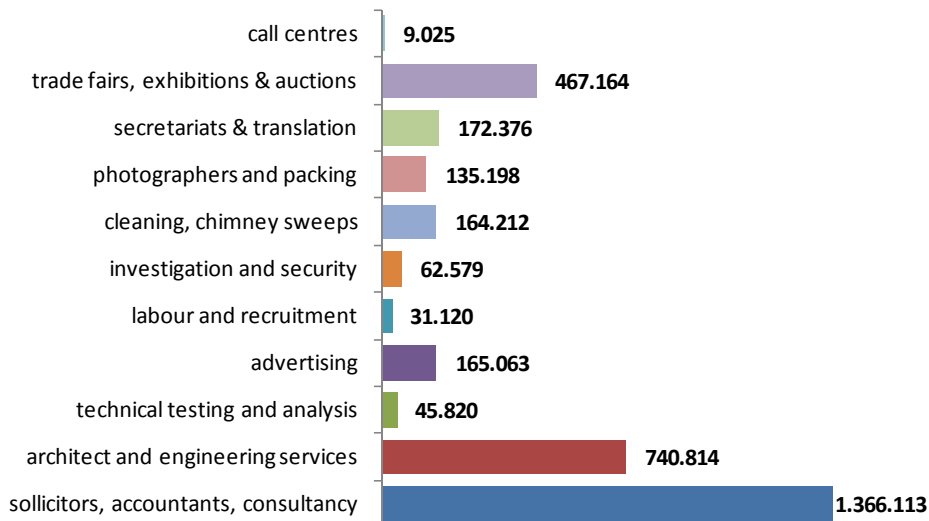


Fig. 31

Trade Fairs

In terms of the size of the buildings, the trade fair exhibition halls are an interesting subsection at NEC 5-digit level. Germany alone boasts 2,7 mln. m² of trade fair exhibition hall floor area. In total EU-27 is estimated to have ca. 10 mln. m² of trade fair exhibition area. At a ceiling height of 8 m this comes down to ca. **80 mln. m³**. Largest 5 fairs in EU: Hannover, Milano Fiera, Frankfurt, Cologne, Dusseldorf.²⁵

6.5 Transportation and communication

6.5.1 Transportation

It is estimated that the EU has around 10.000 manned train stations, i.e featuring at least one heated area. The size of the heated area may range from a one-man ticket counter to the arrivals & departures hall of an international high speed rail station. As a first guess, the heated area is estimated at 200 m², including the company head-offices. This brings the total to 2 mln. m² and around **8 mln. m³**.

There are around 25 large cities in the EU that feature a subway-network. Per network, around 100 underground stations are estimated, which require ventilation. In total, these 2500 underground stations will have a floor area of 2,5 mln. m² and a total ventilated volume of **5 mln. m³**.

The CIA World Factbook reports 3.376 airfields in the EU (2009), of which 1.981 with a paved runway and presumably some heated area. Of the latter it is estimated that around 200-300 airports host commercial flights, of which again around 30 large airports. Estimating the latter at 200.000 m² (2 mln. m³, excluding shops) a piece, 250 other commercial airports at 2.000 m² (10.000 m³) and 1600 small airports at 200 m² (1000 m³) per unit, the total is around **64 mln. m³**.

For harbour buildings (port authorities, waiting hall ferry's etc.) , in as much as they are not already taken into account under the heading 'wholesale', it is difficult to make an accurate estimate. A figure of **3 mln. m³** is given.

For the whole transport sector, excluding the building area already taken into account under other headings (retail, petrol stations, motels, restaurants, etc.), the total is estimated at around **80 mln. m³**, considerably less than 1% of total mentioned in figure 1.

6.5.2 Communication

Statistics on post offices are extremely volatile, given the trends of privatisation, internet and mix of mail services with other activities (banking, shops). A very rough estimate is that typical mail activities of larger mail-offices can be partitioned to around **20 mln. m³** gross floor area in the EU.²⁶

²⁵ AUMA report 2009. Note that in Belgium, the Brussels Exhibition Park (114.000 m² hall area) is the largest. In NL this is Jaarbeurs (100.000 m²).

²⁶ Basis of estimate: NL still has 250 'larger' mainl-offices. EU=30xNL. At 1000 m²/building for specific mail-linked activities this gives 7,5 mln. m² (20 mln. m³). Note that NL has around 1.850 mail-offices mixed with shops (headcount is under 'retail').

Computer and telephone data centres (a.k.a. ‘server farms’) accounted for 61,4 TWh of electricity consumption in the US in 2006.²⁷ At the same time, the energy use in the EU-27 was lagging some 20% behind²⁸, but it is assumed that today the EU-27 will have the same 10-11 mln. servers installed as the US and will also be spending some 60 TWh/a on data centres. Of this, 22% (13,2 TWh/a) is attributed to air-conditioning and ventilation. In principle, this type of air-conditioning and cooling is **outside the scope** of the study, because it concerns process-cooling and not comfort cooling (no people). But the figure is important enough to mention here, because it can explain 1-2% of total HVAC stock of chillers or AHU’s. At an ICT heat dissipation of 1 kW/m² floor area, 45 TWh/a ICT electricity use, 8000 h operation, a ceiling height of 3,5 m, the data centres represent around 6 mln. m² of gross floor area and 20 mln. m³, but the cooling performance is of course much higher than for comfort cooling.

Note that the ventilation of tunnels and parking garages²⁹, as well as the ventilation and conditioning of motor vehicles, trains, ships and aircraft are **outside the scope** of the underlying study.

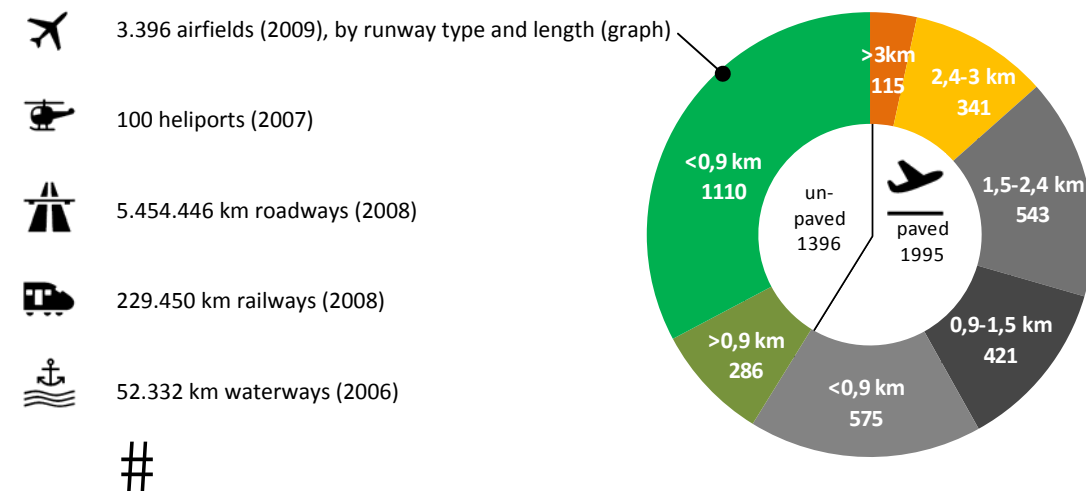


Fig. 32

6.6 Financial institutions

²⁷ Report to Congress on Server and Data Center Energy Efficiency Public Law 109-431 U.S. Environmental Protection Agency ENERGY STAR Program, August 2, 2007.

²⁸ ECN, Data hotels, report 2008 with data 2007 on the Netherlands (average EU internet density): 1,6 TWh. EU=30xNI → 48 TWh. Of this 22% went into HVAC

²⁹ For the sake of estimating the total ventilation market it is mentioned here that the EU-27 has 5860 km of tunnels (CIA World Factbook data 1.1. 2009), including railroad (ca. 23%), subway(28%), road tunnels (49% of safety regulated km capacity). Regulated tunnels (>300 m) are on average ca. 1,2 km/tunnel long and account for ¼ of the total km. This means around 3660 tunnels with sufficient ventilation capacity to evacuate toxic fumes. Typical fan-values found are 2 supply fans (90 m³/s) and 2 exhaust fans (70 m³/s) per tunnel, amounting to a total of capacity of 320 m³/s or 1,15 mln. m³/h per tunnel. Assumed fans work at 50% part load, i.e. around 0,6 mln. m³/h. Total EU: 2,2 bln. m³/h → 19272 bln. m³/a (to check! extremely high!). Indoor parking garages also under investigation; also there the ventilation rate is high.

Belga (2007) reports an average density of 1 EU bank branch office per 2.230 inhabitants. At 500 mln. inhabitants this means 220.000 bank branch offices in the EU. At an estimated average of 200 m² (800 m³) per office (including ATM area, including head-office) this comes down to a heated volume of **180 mln. m³**.

7 Ventilation in primary and secondary sector

7.1 Introduction

Although primary and secondary sector are outside the strict scope of the study they are relevant to complete the statistical overview of the number of ventilation units installed in the EU. The diagrams are extracts from the VHK Business & Public Sector Statistics project. A more detailed breakdown at NACE 5-digit level can be found in Annex I.

As regards the total volume of the buildings involved, the underlying study will rely on the estimates made in the preparatory study on boilers (DG ENER – Lot 1).

7.2 Primary sector

The DG ENER Lot 1 preparatory study concludes that the primary sector accounted for 3,3% of the total heated building volume (at 18 °C). This volume of 3,6 bln. m³ relates primarily to greenhouses [mainly NACE 01.120] and farming of swine and poultry [NACE 01.230- 01.250].

This does not take into account unheated buildings with mechanical ventilation. Furthermore, it should be noted that the ventilation of deep mines, very few mines but characterized by high air exchange rates, in NACE codes 10-14 is considered as process ventilation and therefore excluded from the scope (see Annex II, Exemptions).

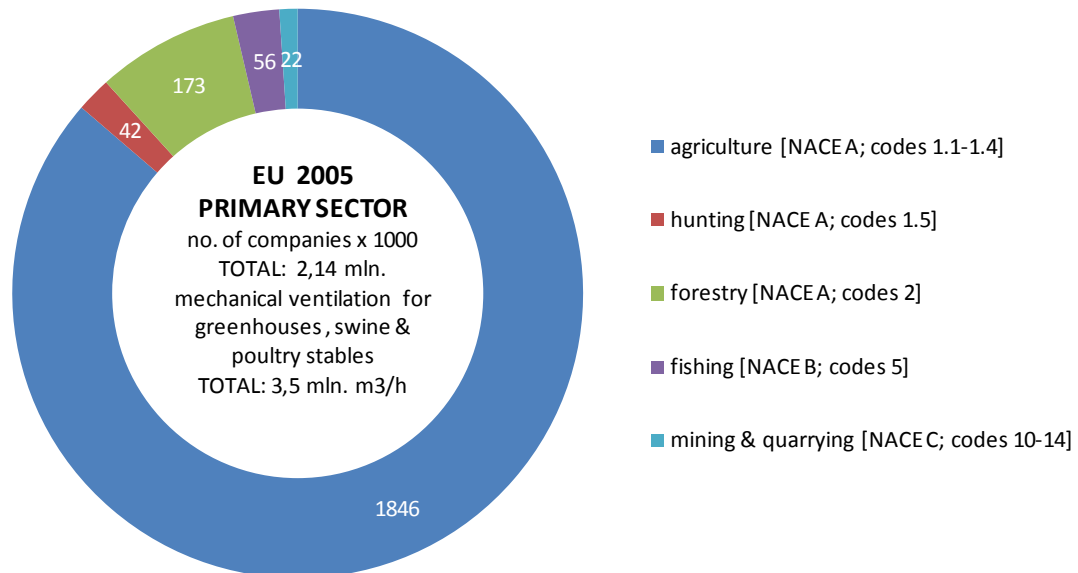


Fig. 33

Table 12. Agriculture (NACE 1.1 - 1.4) no. of companies

| Code | Description | Number |
|----------------------------------------------|-----------------------------------------------------------------------|------------------|
| A - Agriculture, hunting and forestry | | |
| 01.110 | Growing of cereals and other crops n.e.c. | 650.415 |
| 01.120 | Growing of vegetables, horticultural specialties and nursery products | 267.276 |
| 01.130 | Growing of fruit, nuts, beverage and spice crops | 154.464 |
| 01.210 | Farming of cattle, dairy farming | 62.816 |
| 01.220 | Farming of sheep, goats, horses, donkeys and mules | 39.042 |
| 01.230 | Farming of swine | 55.531 |
| 01.240 | Farming of poultry | 93.613 |
| 01.250 | Other farming of animals | 44.886 |
| 01.300 | Growing of crops combined with farming of animals (mixed farming) | 86.980 |
| 01.410 | Agricultural service activities; landscape gardening | 318.381 |
| 01.420 | Animal husbandry service activities, except veterinary activities | 72.296 |
| Total NACE 1.1 - 1.4 | | 1.845.700 |

7.3 Secondary sector

The secondary sector comprises Manufacturing (NACE section D), Energy (NACE section E), Construction (NACE section F). As an illustration only the company count in the manufacturing industry is given.

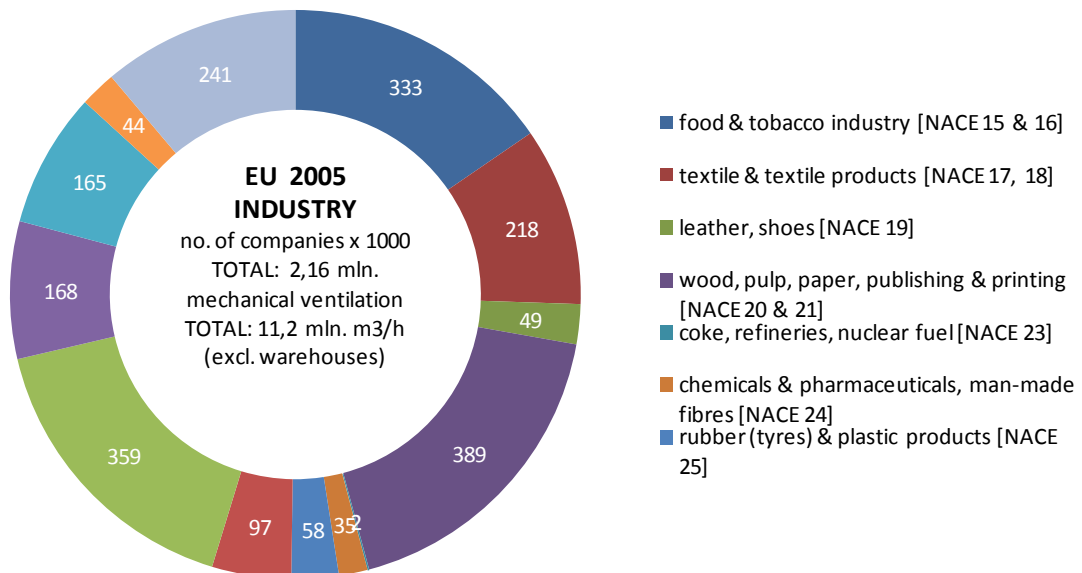


Fig. 34

Table 13. EU-27 Manufacturing industry 2005, NACE Section D (Eurostat, 2009)

| | Value added | | Employment | |
|--------------------------------------------------------------|----------------|---------------|---------------|--------------|
| | EUR billion | % | x1000 | % |
| Manufacturing (NACE Section D) | 1.629,9 | 100,0% | 34.644 | 99,8% |
| Food products; beverages and tobacco (DA) | 199,1 | 12,2% | 4.700 | 13,6% |
| Textiles and textile products (DB) | 53,3 | 3,3% | 2.614 | 7,5% |
| Leather and leather products (DC) | 11,4 | 0,7% | 564 | 1,6% |
| Wood and wood products (DD) | 35,1 | 2,2% | 1.280 | 3,7% |
| Pulp, paper and paper products; publishing and printing (DE) | 134,7 | 8,3% | 2.562 | 7,4% |
| Coke, refined petroleum products and nuclear fuel (DF) | 38,5 | 2,4% | 170 | 0,5% |
| Chemicals, chemical products and man-made fibres (DG) | 178,5 | 10,9% | 1.888 | 5,5% |
| Rubber and plastic products (DH) | 76,1 | 4,7% | 1.700 | 4,9% |
| Other non-metallic mineral products (DI) | 73,5 | 4,5% | 1.596 | 4,6% |
| Basic metals and fabricated metal products (DJ) | 221,9 | 13,6% | 5.045 | 14,6% |
| Machinery and equipment n.e.c. (DK) | 178,4 | 10,9% | 3.636 | 10,5% |
| Electrical and optical equipment (DL) | 189,8 | 11,6% | 3.664 | 10,6% |
| Transport equipment (DM) | 181,9 | 11,2% | 3.152 | 9,1% |
| Manufacturing n.e.c. (DN) | 57,7 | 3,5% | 1.988 | 5,7% |

The DG ENER Lot 1 preparatory study concludes that the industrial units accounted for 10,2% of the total heated building volume (at 18 °C). NACE sectors E and F will make up the largest part of the 'other' category, which accounts for 2,9% . The total volume is thus ca. 14,4 bln. m³. This excludes the warehouses, which are seen as a separate category .

7.4 Warehouses

The DG ENER Lot 1 preparatory study treats (heated) 'Warehouses' as a separate category, accounting for 4,2% of the total EU heated building volume (at 18 °C). The total volume is thus ca. 4,6% bln. m³. This excludes mechanical (exhaust) ventilation of unheated warehouses.

8 Total ventilation demand, summary

The table below summarizes the findings as regards the TOTAL ventilation requirement of heated buildings. The estimate of 68 bln. m³ is within 10% of the estimate of DG ENER Lot 1 as regards the heated building volume.

Table 14. Total ventilation requirement multi-family and non-residential (heated buildings), in mln. m³/h

| | TOTAL | natural ventilatio n | exhaust or supply | balanced ventilatio n | balanced + heat recovery |
|-------------------------------------|--------------|----------------------------|----------------------|-----------------------------|--------------------------------|
| | 10.50 | | | | |
| Low-rise multi-family dwellings | 0 | 7.400 | 2.900 | 100 | 100 |
| High-rise multi-family dwellings | 5.900 | 2.950 | 2.850 | 50 | 50 |
| | 16.40 | | | | |
| | 0 | 10.350 | 5.750 | 150 | 150 |
| | | 63% | 35% | 1% | 1% |
| Health care | 5.400 | 1.620 | 718 | 2.143 | 919 |
| Education | 4.000 | 2.400 | 2.100 | 100 | 200 |
| Public administration | 1.700 | 1.275 | 81 | 241 | 103 |
| Political and religious activities | 1.130 | 1.074 | 57 | 0 | 0 |
| Social, cultural, sports activities | 2.540 | 762 | 338 | 1.008 | 432 |
| | 14.77 | | | | |
| | 0 | 7.131 | 3.294 | 3.492 | 1.654 |
| | | 48% | 22% | 24% | 11% |
| Retail (incl. 260 for malls) | 4.260 | 1.278 | 567 | 1.691 | 725 |
| Wholesale (excl. warehouses) | 1.230 | 492 | 140 | 418 | 179 |
| Trade motor vehicles | 1.270 | 508 | 145 | 432 | 185 |
| Hotels and restaurants | 3.350 | 670 | 509 | 1.520 | 651 |
| Business services | 3.560 | 1.424 | 406 | 1.211 | 519 |
| Transportation & communication | 100 | 40 | 11 | 34 | 15 |
| Financial institutions | 180 | 54 | 24 | 71 | 31 |
| | 13.95 | | | | |
| | 0 | 4.466 | 1.802 | 5.377 | 2.305 |
| | | 32% | 13% | 39% | 17% |
| | 14.40 | | | | |
| Industrial buildings (heated) | 0 | 11.500 | 2.100 | 600 | 200 |
| Warehouses (heated) | 4.600 | 3.680 | 690 | 161 | 69 |
| Agriculture (heated) | 3.600 | 2.700 | 600 | 0 | 300 |
| | 22.60 | | | | |
| | 0 | 18.850 | 1.700 | 1.225 | 825 |
| | | 83% | 8% | 5% | 4% |
| | 67.72 | | | | |
| Total | 0 | 40.797 | 12.546 | 10.245 | 4.933 |
| <i>in % of total</i> | | 60% | 19% | 15% | 7% |

For the share of mechanical ventilation the most optimistic (highest) penetration was assumed in case there were no concrete data (see fig.). This gives a very conservative estimate of the energy saving potential, but at least it avoids pointless disputes over market penetration data where none are available.

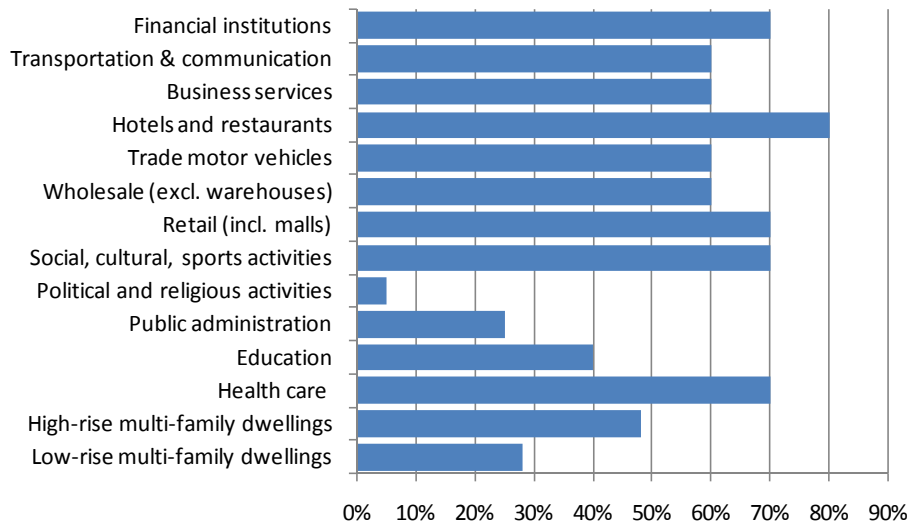


Fig. 35 . Assumed market penetration of mechanical ventilation per sector

Taking the example of multi-family buildings it is estimated that some 30% has to be added for the ventilation of unheated parts of the buildings (staircase, entrance, service area, corridors, etc.). This will be a bit less for the tertiary sector and substantially more for industry buildings. All in all, this would bring the total ventilation to 88 bln. m³ (20 bln. m³ extra). If this ventilation is mechanical (assumed 40%), then it is estimated that it will be simple rooftop fans (exhaust). This means that around 8 bln. m³/h are to be added to the capacity of the rooftop/boxed fans, bring the total of this category to around 20-25 bln. m³/h.

Linking these category to the number of units estimated to be on stock in chapter 2 we find the following

In multi-family dwellings and non-residential buildings **rooftop/boxed fans** represent a total capacity of 20 bln. m³/h. At on average 820 m³/h per unit a conservative estimate results in 24 mln. units installed in the EU-27. This is 44% of the total calculated stock of 55 mln. units (see Chapter 2). This means that a stock of around 30 mln. should be in individual dwellings or in some miscellaneous applications.

The AHU's in multi-family dwellings and non-residential buildings represent a total capacity of 15,2 bln. m³/h. This is based on the assumption that the capacity corresponds with the air exchange requirements according to building standards. The task 2 report finds a stock of 3,1 mln. units and a total capacity of 25,5 bln. m³/h (see Chapter 2). The 1,67 factor difference between the two numbers can be the result of inaccurate estimates, but in reality it can easily be explained by the fact that most installations are designed for operation at 60% part load (at which the pressure still must be sufficient) and a certain amount of duct leakage (at least 10% leakage, but increasing the fan-load by 33%).

Of the AHU stock of 15,2 bln. m³ operational capacity it is estimated that a little less than one-third are heat recovery units. This means that for the 10 bln. balanced units without heat recovery there is a significant energy saving potential by a relatively simple retrofit. But

it should also be remembered that for 30% of balanced units that have separate locations it might be a little more expensive.³⁰

Finally, the high share of natural ventilation, especially in the public sector, promises that there is a substantial potential for energy saving.

³⁰ Beck, dissertation, 2000.

9 Miscellaneous

9.1 End-of-life and other LCA-inputs

The following information was received through the Lot 6 information request:

Carrier

Taking the example of a Carrier air-cooled chiller, its composition is the following :

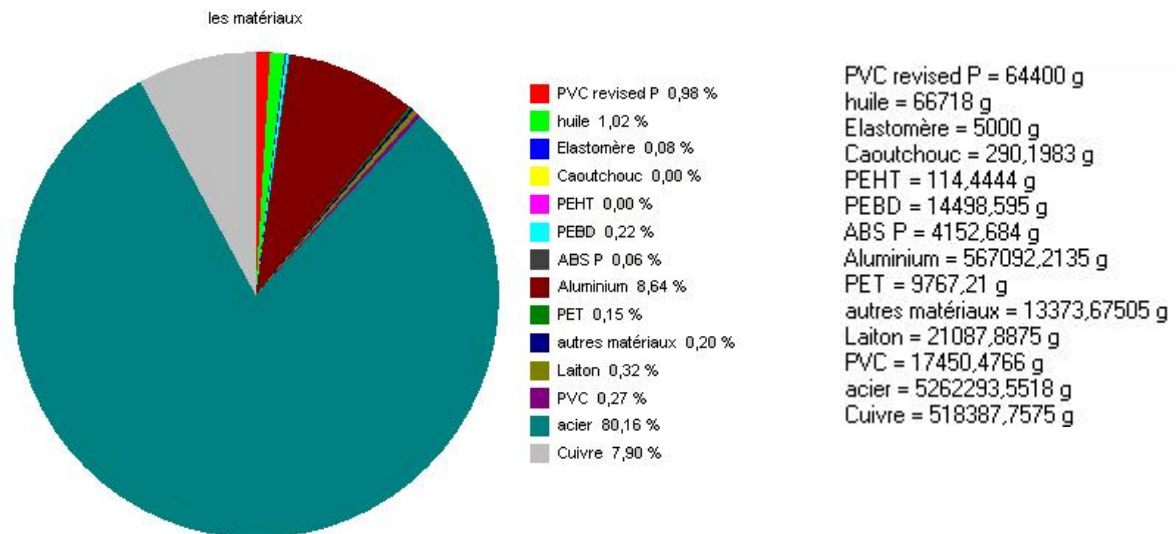


Fig. 36

At the end of lifetime, the chillers are all dismantled, lots of components are recycled for their materials.

- Compressors : as a majority of steel and iron - **Materials recycling**
- Cooler is composed of steel and copper - **Materials recycling**
- Coils standards : tubes (copper) and fin (aluminium) strongly fixed together – **Crushing.**
- Coils MCHX, 100% Aluminium - **Materials recycling.**
- Oil separators : a majority of steel - **Materials recycling**
- Box ventilators : electric motor (**Components recycling**), frame is **recycled** and not fans (PVC P with glass fibre).
- All the frame, panels and sound enclosure are in steel - **Materials recycling**
- Pippings are composed of copper or steel - **Materials recycling**
- Subset economiser : mix of steel and copper strongly fix – **Crushing.**

- Electric & Regulation box : Only steel box is **recycled**, all electronic components are **crushed**.
- Oil, valves and insulation aren't recycled.

“Regarding information about the ecological impact of the production facilities, this topic is covered within the UTC group with clear reduction targets (for energy use, greenhouse gas emissions, water and waste) based on metrics that are considered in absolute terms and not as a percentage of the production. The baseline that has been considered is 2006 figures and reduction targets (i.e. – X%) have been defined to be reached in 2010. For instance, if water usage in 2006 was 100 and the reduction target is -20%, it is expected from the facility that the water usage will be 80 in 2010.

The information about targets and the action plan that is in place to achieve these is communicated to the workers and these are informed about the impact that they can have on these metrics. This contributed to generation of new ideas such as the reduction of the air pressure in the compressed air network. A reduction of 1 bar corresponds to a 7% reduction on the electrical consumption of the air compressors. In Montluel, the pressure has been decreased by 2 bars without any sensible impact of the efficiency of the tooling using the compressed air.

CO2 emissions of the factories are also evaluated and targets for reduction are set. In Montluel, an environmental policy has been developed that focused on both the quantity and the quality of energy used. This led to the development of a sourcing contract with GDF Suez for electricity supplied at 100% by renewable energy sources (hydraulic electricity in this case). This 100% coverage is certified by TÜV-Noard. With this agreement, Carrier Montluel became the first industrial site in France to use green electricity and to have no CO2 emissions linked to electricity.”

9.2 Control settings

There is no statistical information on the use of controls. Anecdotal data suggests that the most common control for exhaust systems is a year-round operation at mid-position (60% of design capacity). For AHU's the most common control is probably a timer control operating 12h/day at 100% of design capacity and 12h/day at 50% of design capacity.

More sophisticated Building Automation systems for AHU's, the use of local (per room) gas/humidity/occupancy sensors and actuators, etc. are believed to be still relatively rare (<20% of cases) but statistical data is lacking.

Technical details on control solutions will be elaborated in Task 4/6 (Technical Analysis, Best Not yet Available Technology BNAT). Classification of control types was given in the Task 1 report.

9.3 Climate & heat recovery

AL-KO THERM GmbH

“For the study it is very important to consider the different climate zones of whole Europe. Energy efficiency of air handling units is mainly effected by the efficiency of air transport and

energy recovery. The benefit of energy recovery depends on the climate data in different regions. It is easy to understand, that the efficiency of heat recovery is different in Scandinavia or Portugal. In our working group in the Eurovent certification company we did a lot of calculations concerning the relationship of energy recovery and different climate zones in Europe.”

The following table is taken from the draft Working Document on Room Air-Conditioners DG ENER Lot 10.

Table 15. – bin number j , outdoor temperature T_j in °C and number of hours per bin h_j corresponding to the reference heating seasons “warmer”, “average”, “colder”

| COOLING SEASON | | | HEATING SEASONS | | | | |
|----------------|-------|-------|-----------------|-------------|------------|------|------|
| j | T_j | h_j | Warmer (W) | Average (A) | Colder (C) | | |
| # | °C | hrs | $h_j W$ | $h_j A$ | $h_j C$ | | |
| 1 | 17 | 205 | 1 to 8 | -30 to -23 | 0 | 0 | 0 |
| 2 | 18 | 227 | 9 | -22 | 0 | 0 | 1 |
| 3 | 19 | 225 | 10 | -21 | 0 | 0 | 6 |
| 4 | 20 | 225 | 11 | -20 | 0 | 0 | 13 |
| 5 | 21 | 216 | 12 | -19 | 0 | 0 | 17 |
| 6 | 22 | 215 | 13 | -18 | 0 | 0 | 19 |
| 7 | 23 | 218 | 14 | -17 | 0 | 0 | 26 |
| 8 | 24 | 197 | 15 | -16 | 0 | 0 | 39 |
| 9 | 25 | 178 | 16 | -15 | 0 | 0 | 41 |
| 10 | 26 | 158 | 17 | -14 | 0 | 0 | 35 |
| 11 | 27 | 137 | 18 | -13 | 0 | 0 | 52 |
| 12 | 28 | 109 | 19 | -12 | 0 | 0 | 37 |
| 13 | 29 | 88 | 20 | -11 | 0 | 0 | 41 |
| 14 | 30 | 63 | 21 | -10 | 0 | 1 | 43 |
| 15 | 31 | 39 | 22 | -9 | 0 | 25 | 54 |
| 16 | 32 | 31 | 23 | -8 | 0 | 23 | 90 |
| 17 | 33 | 24 | 24 | -7 | 0 | 24 | 125 |
| 18 | 34 | 17 | 25 | -6 | 0 | 27 | 169 |
| 19 | 35 | 13 | 26 | -5 | 0 | 68 | 195 |
| 20 | 36 | 9 | 27 | -4 | 0 | 91 | 278 |
| 21 | 37 | 4 | 28 | -3 | 0 | 89 | 306 |
| 22 | 38 | 3 | 29 | -2 | 0 | 165 | 454 |
| 23 | 39 | 1 | 30 | -1 | 0 | 173 | 385 |
| 24 | 40 | 0 | 31 | 0 | 0 | 240 | 490 |
| | | | 32 | 1 | 0 | 280 | 533 |
| | | | 33 | 2 | 3 | 320 | 380 |
| | | | 34 | 3 | 22 | 357 | 228 |
| | | | 35 | 4 | 63 | 356 | 261 |
| | | | 36 | 5 | 63 | 303 | 279 |
| | | | 37 | 6 | 175 | 330 | 229 |
| | | | 38 | 7 | 162 | 326 | 269 |
| | | | 39 | 8 | 259 | 348 | 233 |
| | | | 40 | 9 | 360 | 335 | 230 |
| | | | 41 | 10 | 428 | 315 | 243 |
| | | | 42 | 11 | 430 | 215 | 191 |
| | | | 43 | 12 | 503 | 169 | 146 |
| | | | 44 | 13 | 444 | 151 | 150 |
| | | | 45 | 14 | 384 | 105 | 97 |
| | | | 46 | 15 | 294 | 74 | 61 |
| total | | 2602 | total | | 3590 | 4910 | 6446 |

9.4 Ductwork

Lindab GmbH

“We propose to have a look to the tightness of the ducts. The leakage is sometime 10% and more of the airflow, resulting a 33% higher energy consumption of the fan.

My intention is to point at the problem with leak ducts and I hope you recognize the impact to the energy consumption of a ventilation system.

Please note, there is a study of the European commission attached, showing the situation and the consequences.... It is 10 years old, but there is no regulation.

So in 2007 more than a half of the installed ducts in Germany are not according to the valid norms.”

Attachment: Carrié et al. (ed.), Improving Ductwork, study in the framework of the European Commission Energy Conservation in Buildings Programme, 130 pp., AIVC / SAVE-DUCT, 1999.

References

To do

ANNEX I

VHK Business & public sector statistics

| Code | Description | Number | Code | Description | Number |
|----------------------------------------------|------------------------------------------------------------------------------|------------------|--------------------------|--------------------------------------------------------------------------------------------|---------------|
| | | | 14.111 | Quarrying of ornamental and building stone | 5.492 |
| | | | 14.121 | Quarrying of cement | 178 |
| | | | 14.122 | Quarrying of limestone, gypsum and chalk | 617 |
| | | | 14.130 | Quarrying of slate | 151 |
| | | | 14.210 | Operation of gravel and sand pits | 9.412 |
| | | | 14.220 | Mining of clays and kaolin | 331 |
| | | | 14.301 | Mining of chemical and fertilizer minerals | 283 |
| | | | 14.400 | Production of salt | 1.098 |
| | | | 14.501 | Other mining and quarrying n.e.c. | 1.204 |
| | | | total | | 18.766 |
| | | | TOTAL GROUP C | | 22.256 |
| Code | Description | Number | Code | Description | Number |
| | | | D - Manufacturing | | |
| | | | 15.111 | Slaughterhouses | 5.517 |
| | | | 15.112 | Meat cutting industry | 2.930 |
| | | | 15.121 | Poultry meat industry | 1.883 |
| | | | 15.122 | Industrial preparation of meatbased products | 6.951 |
| | | | 15.130 | Meat and poultry meat product industry | 27.357 |
| | | | 15.201 | Processing and conserving (fresh) fish and fishproducts | 3.105 |
| | | | 15.202 | Production of frozen fish and fishproducts | 1.121 |
| | | | 15.310 | Potatoe processing industry | 1.721 |
| | | | 15.320 | Fruit and vegetable juice industry | 916 |
| | | | 15.331 | Processing and preserving of vegetables | 3.879 |
| | | | 15.332 | Processing and preserving of fruit | 3.444 |
| | | | 15.411 | Manufacture of crude oils and fats | 6.578 |
| | | | 15.421 | Manufacture of refined oils and fats | 2.166 |
| | | | 15.430 | Fabrication of margarine | 100 |
| | | | 15.511 | Cheese industry | 4.779 |
| | | | 15.512 | Fabrication of milk and other fresh (dairy) products | |
| | | | 15.513 | Fabrication of butter | |
| | | | 15.514 | Other dairy product industry | 1.273 |
| | | | 15.520 | Ice cream industry | 2.315 |
| | | | 15.611 | Grain mills | 5.036 |
| | | | 15.612 | Industry for breakfast cereals, blended flour mixes and other prepared grain mill products | 1.096 |
| | | | 15.620 | Starch industry | 129 |
| | | | 15.710 | Industry for prepared feeds for farm animals | 4.321 |
| | | | 15.720 | Industry for prepared pet foods | 542 |
| | | | 15.811 | Bakeries - Industrial fabrication of bread and pastries | 2.644 |
| | | | 15.812 | Bakeries - Baking of bakery products | 27.627 |
| | | | 15.813 | Bakery and pastry shops | 142.387 |
| | | | 15.814 | Pastry shops | 20.831 |
| | | | 15.821+ | 15.822 Rusk and biscuit industry | 3.597 |
| | | | 15.830 | Sugar industry and Industry for sugar confectionery | 400 |
| | | | 15.840 | Industry for cocoa; chocolate and sugar confectionery | 3.950 |
| | | | 15.850 | Industry for macaroni, noodles, couscous and similar farinaceous products | 7.651 |
| | | | 15.860 | Coffee and tea industry | 3.202 |
| | | | 15.870 | Industry for condiments and seasonings | 726 |
| | | | 15.880 | Industry for homogenised food preparations and dietetic food | 657 |
| | | | 15.890 | Manufacture of other food products n.e.c. | 5.904 |
| | | | 15.910 | Manufacture of distilled potable | 2.208 |
| A - Agriculture, hunting and forestry | | | | | |
| 01.110 | Growing of cereals and other crops n.e.c. | 650.415 | | | |
| 01.120 | Growing of vegetables, horticultural specialties and nursery products | 267.276 | | | |
| 01.130 | Growing of fruit, nuts, beverage and spice crops | 154.464 | | | |
| 01.210 | Farming of cattle, dairy farming | 62.816 | | | |
| 01.220 | Farming of sheep, goats, horses, donkeys and mules | 39.042 | | | |
| 01.230 | Farming of swine | 55.531 | | | |
| 01.240 | Farming of poultry | 93.613 | | | |
| 01.250 | Other farming of animals | 44.886 | | | |
| 01.300 | Growing of crops combined with farming of animals (mixed farming) | 86.980 | | | |
| 01.410 | Agricultural service activities; landscape gardening | 318.381 | | | |
| 01.420 | Animal husbandry service activities, except veterinary activities | 72.296 | | | |
| 01.500 | Hunting, trapping and game propagation, including related service activities | 42.412 | | | |
| TOTAL GROUP A | | 1.888.111 | | | |
| 02.011 | Forest owners; producers of standing forest and standing timber | 113.875 | | | |
| 02.012 | Reafforestation and forest conservation companies | 6.404 | | | |
| 02.013 | Loggers | 12.641 | | | |
| 02.014- | 02.019 Forest tree nurseries and other forestry companies | 28.186 | | | |
| 02.021 | Timber evaluation societies | 168 | | | |
| 02.029 | Other service companies related to forestry and logging | 12.687 | | | |
| total | | 173.960 | | | |
| B - Fishing | | | | | |
| 05.011 | Sea water trawlers | 25.255 | | | |
| 05.012 | Other sea water fishermen | 16.070 | | | |
| 05.013 | Fresh water fishermen | 4.867 | | | |
| 05.021 | Fish farms | 6.102 | | | |
| 05.022 | Producers of fish fry | 2.062 | | | |
| 05.023 | Producers of crustaceans | 1.045 | | | |
| 05.024 | Producers of molluscs | 663 | | | |
| 05.025 | Growers of aquatic plants | 234 | | | |
| TOTAL GROUP B | | 56.300 | | | |
| C - Mining and quarrying | | | | | |
| 10.100 | Mining and agglomeration of hard coal | 360 | | | |
| 10.200 | Mining and agglomeration of lignite | 188 | | | |
| 10.300 | Extraction and agglomeration of peat | 969 | | | |
| total | | 1.517 | | | |
| 11.110 | Extraction of crude petroleum and natural gas | 611 | | | |
| 11.200 | Service companies incidental to oil and gas extraction | 377 | | | |
| total | | 988 | | | |
| 12.000 | Mining of uranium and thorium ores | 20 | | | |
| total | | 20 | | | |
| 13.100 | Mining of iron ores | 87 | | | |
| 13.200 | Mining of non-ferrous metal ores, except uranium and thorium ores | 878 | | | |
| total | | 965 | | | |

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| | | | | | |
|---------|------------------------------------------------------------------------------------------------------------------------------|---------|---------|------------------------------------------------------------------------------------------|---------|
| 15.920 | alcoholic beverages | | 18.300 | Fur industry | 6.710 |
| | Production of ethyl alcohol from fermented materials | 875 | total | | 133.708 |
| 15.931 | Manufacture of wines | 10.388 | 19.100 | Tanneries | 4.473 |
| 15.932 | Manufacture of champagne | 2.485 | 19.200 | Industry for luggage, handbags, saddlery etc. | 16.927 |
| 15.940 | Manufacture of cider and other fruit wines | 907 | 19.301 | Industry for footwear | 27.668 |
| 15.950 | Manufacture of other non-distilled fermented beverages | 179 | total | | 49.068 |
| 15.960 | Manufacture of beer | 1.141 | 20.101 | Saw-mills | 18.064 |
| 15.970 | Manufacture of malt | 54 | 20.102 | Planing-mills | 3.647 |
| 15.980 | Production of mineral waters and soft drinks | 7.479 | 20.103 | Wood impregnation plants | 2.287 |
| total | | 332.452 | 20.201 | Industry for veneer sheets, plywood and laminboard | 1.419 |
| 16000 | Tobacco industry | 471 | 20.202 | Industry for particle board | 345 |
| total | | 471 | 20.203 | Industry for fibreboard | 896 |
| | | | 20.301 | Industry for prefabricated wooden buildings | 44.293 |
| 17.110 | Preparation and spinning of cotton-type fibres | 819 | 20.302 | Industry for other builders' carpentry and joinery | 42.241 |
| 17.121 | Spinning of woolen-type fibers | 855 | 20.400 | Industry for wooden containers | 10.172 |
| 17.122 | Preparation of woolen-type fibers | 1.514 | 20.511 | Industry for other products of wood | 30.593 |
| 17.131 | Spinning of worsted-type fibers | 77 | 20.521 | Industry for articles of cork | 1.551 |
| 17.132 | Preparation of worsted-type fibers | 805 | 20.522 | Industry for articles of straw, cane etc. | 1.095 |
| 17.140 | Preparation and spinning of flax-type fibers | 397 | total | | 156.602 |
| 17.150 | Throwing and preparation of silk, including from noils, and throwing and texturing of synthetic or artificial filament yarns | 1.437 | 21.111- | 21.113 Industry for pulp | 311 |
| | | | 21.121 | Industry for newsprint | 101 |
| | | | 21.122 | Industry for other printing paper | 270 |
| 17.160 | Manufacture of sewing threads | 368 | 21.123 | Industry for kraft paper and paperboard | 287 |
| 17.170 | Preparation and spinning of other textile fibres | 1.765 | 21.129 | Industry for other paper and paperboard | 1.216 |
| 17.210 | Cotton-type cloth mills | 2.608 | 21.211 | Industry for corrugated paper and paperboard and for containers of corrugated paperboard | 2.534 |
| 17.220 | Woolen-type weaving - carded cycle | 1.382 | | Industry for other containers of paper and paperboard | 5.273 |
| 17.230 | Woolen-type weaving - combed cycle | 1.753 | 21.219 | Industry for household and sanitary goods and for toilet requisites | 850 |
| 17.240 | Silk-type weaving | 1.145 | 21.220 | Industry for paper stationery | 2.982 |
| 17.250 | Other textile weaving | 1.880 | 21.230 | Wallpaper industry | 129 |
| 17.300 | Textile finishing industry | 7.062 | 21.240 | Industry for other articles of paper and paperboard n.e.c. | 4.015 |
| 17.401 | Curtain industry | 8.774 | 21.250 | | |
| 17.402 | Industry for bed linen and other linen goods | 4.402 | total | | 17.970 |
| 17.403 | Industry for tarpaulins, tents, sails etc. | 10.527 | 22.110 | Book publishers | 23.980 |
| 17.510 | Industry for carpets and rugs | 1.049 | 22.121 | Publishers of daily newspapers | 5.452 |
| 17.520 | Industry for cordage, rope, twine and netting | 1.029 | 22.122 | Publishers of advertising newspapers | 3.656 |
| 17.530 | Industry for nonwovens and articles made from nonwovens, except apparel | 588 | 22.130 | Publishers of journals and periodicals | 25.872 |
| 17.541 | Industry for ribbon, trimmings and lace | 777 | 22.140 | Publishers of sound recordings | 16.910 |
| 17.549 | Industry for various other textiles n.e.c. | 12.608 | 22.150 | Other publishers | 7.360 |
| 17.600 | Industry for knitted and crocheted fabrics | 6.791 | 22.210 | Printers of daily newspapers | 1.180 |
| 17.710 | Industry for knitted and crocheted hosiery | 1.638 | 22.221 | Printers of periodicals | 2.368 |
| 17.720 | Industry for knitted and crocheted pullovers, cardigans and similar articles | 11.529 | 22.222 | Book printers and other printers | 59.228 |
| total | | 83.579 | 22.230 | Bookbinding industry | 6.746 |
| | | | 22.240 | Pre-press industry | 20.275 |
| 18.100 | Industry for leather clothes | 3.167 | 22.250 | Other service establishments related to printing | 36.142 |
| 18.210 | Industry for workwear | 442 | 22.310 | Industry for the reproduction of sound recording | 2.743 |
| 18.212 | Manufacture of clothes by measuring (tailor) | 11.961 | 22.320 | Industry for the reproduction of video recording | 1.738 |
| 18.221 | Industry for other outerwear for men and boys | 34.629 | 22.330 | Industry for the reproduction of computer media | 1.095 |
| 18.222 | Industry for other outerwear for women and girls | 36.574 | total | | 214.745 |
| 18.231- | 18.234 Industry for underwear | 5.899 | 23.100 | Industry for coke oven products | 46 |
| 18.241 | Industry for baby clothing | 604 | 23.201 | Industry for refined petroleum products | 1.526 |
| 18.242 | Industry for sports clothing | 10.547 | 23.300 | Industry for nuclear fuel | 81 |
| 18.243 | Industry for hats and caps | 11.581 | | | |
| 18.244 | Industry for other wearing apparel and accessories n.e.c. | 11.594 | | | |

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| | | | | | |
|--------|-----------------------------------------------------------------------------------------------------------------------|--------|---------|------------------------------------------------------------------------------------------------------------|--------|
| total | | 1.653 | 26.403 | Industry for other construction products, in baked clay | 1.325 |
| 24.110 | Industry for industrial gases | 639 | 26.510 | Manufacture of cement | 531 |
| 24.120 | Industry for dyes and pigments | 451 | 26.520 | Manufacture of lime | 784 |
| 24.130 | Industry for other inorganic basic chemicals | 1.271 | 26.530 | Manufacture of plaster | 190 |
| 24.140 | Industry for other organic basic chemicals | 2.284 | 26.610 | Industry for concrete products for construction purposes | 10.085 |
| 24.150 | Manufacture of fertilizers, nitrogen compounds | 1.457 | 26.620 | Industry for plaster products for construction purposes | 580 |
| 24.160 | Manufacture of basic plastics | 1.991 | 26.630 | Industry for ready-mixed concrete | 5.869 |
| 24.170 | Manufacture of synthetic rubber in primary forms | 144 | 26.640 | Industry for mortars et bétons secs | 497 |
| 24.200 | Manufacture of pesticides and other agro-chemical products | 760 | 26.650 | Industry for fibre cement | 248 |
| 24.300 | Paint industry | 4.568 | 26.660 | Industry for other articles of concrete, plaster and cement | 3.997 |
| 24.410 | Industry for basic pharmaceutical products | 712 | 26.701 | Industry for building stone products | 18.242 |
| 24.420 | Industry for pharmaceutical preparations | 3.024 | 26.709 | Industry for ornamental stone products | 14.868 |
| 24.430 | Industry for other pharmaceutical products | 616 | 26.810 | Industry for abrasive products | 913 |
| 24.511 | Industry for soap and detergents | 2.854 | 26.821- | 26.829 Industry for stone and mineral wool products and various other non-metallic mineral products n.e.c. | 3.012 |
| 24.512 | Industry for cleaning and polishing preparations | 653 | total | | 97.079 |
| 24.520 | Industry for perfumes and toilet preparations | 5.837 | 27.100 | Industry for basic iron and steel, steel tubes and of ferro-alloys | 1.438 |
| 24.610 | Industry for explosives | 622 | 27.210 | Manufacture of cast iron tubes | 69 |
| 24.620 | Industry for glues and gelatines | 533 | 27.221 | Manufacture of steel tubes | 321 |
| 24.630 | Industry for essential oils, for photographic chemical material and prepared unrecorded media and for man-made fibres | 1.682 | 27.222 | Manufacture of accessories of steel tubes | 1.059 |
| 24.640 | Manufacture of photographic chemical material | 147 | 27.310 | Cold drawing mills | 160 |
| 24.650 | Manufacture of prepared unrecorded media | 294 | 27.320 | Cold rolling mills for narrow strips | 176 |
| 24.661 | Manufacture of other chemical products n.e.c. | 3.925 | 27.330 | Cold forming mills | 1.293 |
| 24.700 | Manufacture of man-made fibres | 289 | 27.340 | Wire drawing mills | 594 |
| total | | 34.754 | 27.350 | Other first processing of iron and steel | 448 |
| 25.110 | Manufacture of rubber tyres and tubes | 284 | 27.410 | Precious metals mills | 396 |
| 25.120 | Retreading and rebuilding of rubber tyres | 1.259 | 27.420 | Aluminium mills | 322 |
| 25.130 | Industry for other rubber products | 5.643 | 27.422 | First processing of aluminium | 608 |
| 25.210 | Industry for plastic plates, sheets, tubes and profiles | 5.127 | 27.430 | Lead, zinc and tin mills | 95 |
| 25.220 | Industry for plastic packing goods | 7.471 | 27.432 | First processing of lead, zinc or tin | 172 |
| 25.230 | Industry for builders' ware of plastic | 8.106 | 27.440 | Copper mills | 27 |
| 25.240 | Industry for other plastic products | 11.630 | 27.442 | First processing of copper | 283 |
| 25.250 | Manufacture of plastic technical parts | 18.259 | 27.450 | Other metal mills | 500 |
| total | | 57.779 | 27.510 | Iron foundries | 1.002 |
| 26.110 | Industry of flat glass | 229 | 27.520 | Steel foundries | 303 |
| 26.120 | Shaping and processing of flat glass | 7.406 | 27.530 | Light metal foundries | 1.755 |
| 26.130 | Industry for hollow glass | 2.855 | 27.540 | Other metal foundries | 2.101 |
| 26.140 | Glass fibre industry | 332 | total | | 13.123 |
| 26.151 | Industry for technical glass products | 4.728 | 28.110 | Industry for metal structures and parts of structures | 49.765 |
| 26.152 | Industry for isolating glass products | 84 | 28.121 | Industry for builders' carpentry and joinery of metal | 54.885 |
| 26.210 | Industry for ceramic household and ornamental articles | 14.534 | 28.210 | Industry for tanks, reservoirs and containers of metal | 2.583 |
| 26.220 | Industry for ceramic sanitary fixtures | 246 | 28.220 | Industry for central heating radiators and boilers | 2.851 |
| 26.230 | Industry for ceramic insulators | 60 | 28.301 | Industry for steam generators, except central heating hot water boilers | 66 |
| 26.240 | Industry for other technical ceramic products | 125 | 28.302 | Nuclear boiler making | 106 |
| 26.250 | Industry for other ceramic products | 1.201 | 28.303 | Manufacture of boilers and pipes | 18.699 |
| 26.260 | Industry for refractory ceramic products | 566 | 28.401 | Industry for forging, pressing of metal | 5.407 |
| 26.300 | Industry for ceramic tiles and flags | 2.105 | 28.402 | Industry for stamping and roll forming of metal | 9.379 |
| 26.401 | Industry for bricks in baked clay | 777 | 28.403 | Industry for powder metallurgy | 159 |
| 26.402 | Industry for tiles in baked clay | 689 | 28.510 | Industry for the treatment and coating of metals | 24.793 |
| | | | 28.520 | Workshops for general mechanical engineering | 99.814 |
| | | | 28.610 | Cutlery industry | 2.369 |
| | | | 28.621 | Industry for shaping tools | 5.503 |
| | | | 28.622 | Industry for cutting tools | 3.669 |
| | | | 28.629 | Industry for other tools | 5.842 |
| | | | 28.630 | Industry for locks and hinges | 5.717 |

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| | | | | | |
|--------|---------------------------------------------------------------------------------------------------------------------|---------|---------|-----------------------------------------------------------------------------------------------------------------------|---------|
| 28.710 | Industry for steel drums and similar containers and Industry for light metal packaging | 482 | 29.565 | assembly Industry for various other special purpose machinery n.e.c. | 6.787 |
| 28.720 | Industry for light metal packaging | 972 | 29.601 | Industry for ammunition | 185 |
| 28.730 | Industry for wire products | 3.793 | 29.602 | Industry for weapons | 1.075 |
| 28.741 | Industry for fasteners, screw machine products | 2.223 | 29.710 | Industry for domestic appliances n.e.c. | 2.481 |
| 28.742 | Industry for springs | 1.288 | 29.720 | Manufacture of non-electric domestic appliances | 952 |
| 28.743 | Industry for chains | 172 | total | | 160.037 |
| 28.751 | Industry for household and sanitary goods | 4.928 | 30.010 | Industry for office machinery | 619 |
| 28.752 | Fabrication of small metal items | 4.401 | 30.020 | Industry for computers and other information processing equipment | 7.542 |
| 28.753 | Industry for various other fabricated metal products n.e.c. | 35.997 | total | | 8.162 |
| total | | 345.866 | | | |
| 29.111 | Industry for engines and turbines, except aircraft, vehicle and cycle engines | 2.421 | 31.101 | Industry for electric motors, generators and transformers of small and average power | 1.861 |
| 29.121 | Fabrication of pumps | 1.885 | 31.102 | Industry for electric motors, generators and transformers of large power | 354 |
| 29.122 | Fabrication of hydraulic and pneumatic transmissions | 3.324 | 311C Re | paration of electric materials | 7.825 |
| 29.123 | Fabrication of compressors | 712 | 31.201 | Industry for electricity distribution and control apparatus | 7.025 |
| 29.130 | Industry for taps and valves | 2.862 | 31.202 | Industry for electricity distribution and control apparatus | 1.070 |
| 29.141 | Industry for bearings, gears and gearing | 778 | 31.300 | Industry for insulated wire and cable and for accumulators, primary cells and primary batteries | 2.272 |
| 29.142 | Industry for driving elements | 1.082 | 31.400 | Manufacture of accumulators, primary cells and primary batteries | 541 |
| 29.211 | Industry for furnaces and furnace burners | 2.357 | 31.501 | Industry for lamps and lighting fittings | 571 |
| 29.221 | Industry for lifting equipment | 5.392 | 31.502 | Fabrication of autonomous electrical security appliances | 359 |
| 29.222 | Industry for handling equipment | 9.756 | 31.503 | Industry for light bulbs and fluorescent tubes | 7.123 |
| 29.231 | Industry for non-domestic cooling equipment | 11.748 | 31.610 | Industry for electrical equipment for engines and vehicles n.e.c. | 1.287 |
| 29.232 | Industry for ventilation equipment | 3.712 | 31.621 | Industry for electrical and electromagnetic equipment for industrial use | 6.510 |
| 29.241 | Industry for weighing machinery | 2.999 | 31.622 | Industry for other electrical equipment n.e.c. | 13.323 |
| 29.243 | Industry for chemical industry machinery | 1.974 | total | | 50.121 |
| 29.243 | Industry for other general purpose machinery n.e.c. | 22.764 | 32.100 | Manufacture of electronic valves and tubes and other electronic components | 8.154 |
| 29.311 | Industry for agricultural tractors | 4.463 | 32.201 | Manufacture of radio and television equipment and apparatuses | 6.371 |
| 29.321 | Industry for other agricultural and forestry machinery - Réparation de matériel agricole | 13.690 | 32.202 | Manufacture of communication equipment and apparatuses | 8.613 |
| 29.322 | Industry for other agricultural and forestry machinery - Fabrication de matériel agricole | 5.382 | 32.300 | Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods | 3.754 |
| 29.410 | Industry for portable hand held power tools | 6.137 | total | | 26.891 |
| 29.420 | Industry for metalworking machine tools | 2.100 | 33.101 | Industry for medical and surgical equipment and orthopedic appliances | 25.849 |
| 29.430 | Industry for other machine tools n.e.c. | 2.977 | 33.102 | Dental technicians' workshops | 32.735 |
| 29.510 | Industry for machinery for metallurgy | 1.382 | 33.201 | Industry for instruments and appliances for navigating | 1.728 |
| 29.521 | Industry for machinery for mining, quarrying and construction | 2.397 | 33.202 | Industry for instruments and appliances for measuring, checking, testing and other scientific and technical purposes | 11.280 |
| 29.522 | Fabrication de matériels de travaux publics | 1.190 | 33.300 | Industry for industrial process control equipment | 7.766 |
| 29.530 | Industry for machinery for food, beverage and tobacco processing | 11.530 | 33.401 | Industry for glasses | 4.663 |
| 29.541 | Industry for machinery for textile, apparel and leather production - per a les indústries tèxtils i de la confecció | 3.129 | 33.402 | Industry for optical instruments and photographic equipment | 2.459 |
| 29.542 | Industry for machinery for textile, apparel and leather production - de rentatge i neteja en sec | 1.167 | 33.500 | Industry for watches and clocks | 1.350 |
| 29.543 | Industry for machinery for textile, apparel and leather production - per a les indústries del cuir i del calçat | 916 | total | | 87.830 |
| 29.550 | Industry for machinery for paper and paperboard production | 1.339 | | | |
| 29.561 | Industry for printing machinery | 2.806 | | | |
| 29.562 | Industry for machinery for plastic and rubber processing | 1.923 | | | |
| 29.563 | Manufacture of moulds and models | 11.063 | | | |
| 29.564 | Manufacture of machines of automatic | 1.201 | | | |

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| | | | | | |
|----------------------------------------------|-------------------------------------------------------------------------|------------------|-------------------------|---------------------------------------------------------------------------|------------------|
| 34.100 | Industry for motor vehicles | 2.325 | 40.201 | Manufacture of gas | 1.835 |
| 34.201 | Industry for bodies (coachwork) for motor vehicles | 6.494 | 40.202 | Distribution and trade of gaseous fuels through mains | 474 |
| 34.202 | Industry for trailers and semi-trailers | 1.052 | 40.300 | Steam and hot water supply | 3.762 |
| 34.300 | Industry for parts and accessories for motor vehicles and their engines | 8.365 | 41.001 | Collection, purification and distribution of groundwater | 0 |
| total | | <u>18.236</u> | 41.002 | Collection, purification and distribution of surface water | 7.636 |
| 35.111 | Shipyards - Building and repairing of ships | 6.292 | | | 2.079 |
| 35.120 | Building and repairing of pleasure and sporting boats | 13.120 | TOTAL GROUP E | | 38.955 |
| 35.201 | Industry for locomotives and rolling stock | 973 | F - Construction | | |
| 35.300 | Aircraft industry | 2.779 | 45.111 | Building demolition contractors | 78.214 |
| 35.411 | Motorcycle industry | 856 | 45.112 | Earth moving contractors | 8.632 |
| 35.421 | Bicycle industry | 1.529 | 45.120 | Test drilling and boring contractors | 2.912 |
| 35.430 | Industry for invalid carriages | 257 | 45.211 | Construction of individual houses | 309.022 |
| 35.501 | Industry for other transport equipment n.e.c. | 599 | 45.212 | Construction of various buildings | 106.045 |
| total | | <u>26.406</u> | 45.213 | Construction of industrial, commercial or agricultural structures | 4.185 |
| 36.111 | Industry for chairs and seats for homes and offices | 3.758 | 45.214 | Construction of tunnels, bridges (viaducten etc.), underground work | 672 |
| 36.112 | Industry for chairs and seats for public use and transport | 26.912 | 45.215 | Construction of networks | 11.244 |
| 36.121 | Industry for other office and shop furniture - mostly metal | 5.146 | 45.216 | Construction of electricity and telecommunication lines | 9.109 |
| 36.122 | Industry for other office and shop furniture - mostly non-metal | 29.258 | 45.221 | Contractors for sheet-metal roof covering | 87.860 |
| 36.130 | Industry for other kitchen furniture | 8.243 | 45.222 | Waterproofing and sealing off (étanchéification) | 13.919 |
| 36.141 | Other dining-, bed- and living room furniture industry | 65.349 | 45.229 | Other contractors for other roof covering and frame erection | 42.523 |
| 36.142 | Other garden furniture industry | 7.755 | 45.231 | Contractors for the construction of railways and airfields | 627 |
| 36.150 | Industry for mattresses | 3.675 | 45.232 | Contractors for the construction of motorways, roads and sport facilities | 16.717 |
| 36.210 | Striking of coins and medals | 5.501 | 45.240 | Contractors for the construction of water projects | 2.622 |
| 36.221 | Processing of diamonds and gemstones | 20.819 | 45.250 | Other building and civil engineering contractors | 490.053 |
| 36.222 | Manufacture of jewelry and related articles n.e.c. | 2.941 | 45.310 | Electrical installation contractors | 286.798 |
| 36.300 | Industry for musical instruments | 4.849 | 45.320 | Contractors for insulation work | 16.915 |
| 36.400 | Industry for sports goods | 4.073 | 45.331 | Contractors for heating and sanitary equipment installation | 197.060 |
| 36.501 | Industry for games | 2.950 | 45.332 | Contractors for ventilation equipment installation | 70.991 |
| 36.502 | Industry for toys | 2.378 | 45.333 | Contractors for refrigeration and freezing equipment installation | 15.393 |
| 36.610 | Industry for imitation jewelry | 8.005 | 45.339 | Other plumbing contractors | 3.124 |
| 36.620 | Industry for brooms and brushes | 1.436 | 45.340 | Other building installation contractors | 23.633 |
| 36.631 | Other manufacturing industry n.e.c. | 22.307 | 45.410 | Plastering contractors | 65.542 |
| total | | <u>225.356</u> | 45.421 | Joinery and plastics | 157.773 |
| 37.100 | Industry for recycling metal waste and scrap | 9.727 | 45.422 | Metal fittings | 58.887 |
| 37.201 | Industry for recycling non-metal waste and scrap | 2.173 | 45.430 | Floor and wall covering contractors | 105.590 |
| 37.202 | Industry for recycling non-metal waste and scrap | 4.701 | 45.441 | Painting contractors | 233.238 |
| total | | <u>16.601</u> | 45.442 | Glazing contractors | 16.736 |
| TOTAL GROUP D | | 2.158.490 | 45.451 | Other building completion contractors - Agencement de lieux de vente | 84.838 |
| E - Electricity, gas and water supply | | | 45.452 | Other building completion contractors | 49.596 |
| 40.110 | Production of electricity | 17.175 | 45.500 | Companies for renting construction or demolition equipment with operator | 10.714 |
| 40.120T | ransmission of electricity | 843 | TOTAL GROUP F | | 2.581.182 |
| 40.130 | Distribution and trade of electricity | 5.151 | | | |

VHK Company Table, section G. 50 - Trade and repair motor vehicles (2005), EU-27

| Code | Description | Number | Totals |
|--------|-----------------------------------------------------------------------------------|---------|---------|
| 50.101 | Sales establishments for lorries, buses and specialized motor vehicles | 14.619 | |
| 50.102 | Sales establishments for passenger motor vehicles | 145.457 | |
| 50.103 | Sales establishments for caravans, motorhomes, trailers and semi-trailers | 24.775 | |
| | | | 184.851 |
| 50.201 | Non-specialized maintenance and repair garages for motor vehicles | 211.157 | |
| 50.202 | Garages for bodywork repair, painting and glazing of motor vehicles | 93.112 | |
| 50.203 | Garages for the installation and repair of electrical motor vehicle equipment | 38.092 | |
| 50.204 | Tyre service garages | 48.219 | |
| | | | 390.579 |
| 50.301 | Wholesale establishments for motor vehicle parts and accessories | 28.172 | |
| 50.302 | Retail sale establishments for motor vehicle parts and accessories | 43.114 | |
| | | | 71.286 |
| 50.401 | Sales and repair establishments for motorcycles and related parts and accessories | 17.250 | |
| 50.402 | Sales and repair establishments for motorcycles and related parts and accessories | 4.245 | |
| 50.403 | Sales and repair establishments for motorcycles and related parts and accessories | 19.813 | |
| | | | 41.308 |
| 50.500 | Petrol stations | 67.795 | |
| | | | 67.795 |
| | | | 755.820 |

Table . VHK Company Table, section G. 51 - Wholesale (2005), EU-27

| Code | Description | Number | Totals |
|--------|-------------------------------------------------------------------------------------------------------------------------|---------|---------|
| 51.110 | Agents involved in the sale of agricultural raw materials, live animals, textile raw materials | 10.509 | |
| 51.120 | Agents involved in the sale of fuels, ores, metals and industrial chemicals | 12.710 | |
| 51.130 | Agents involved in the sale of timber and building materials | 23.697 | |
| 51.141 | Agents involved in the sale of machinery, industrial equipment, ships and aircraft, except office ma | 36.140 | |
| 51.142 | Agents involved in the sale of office machinery and computer equipment | 8.492 | |
| 51.150 | Agents involved in the sale of furniture, household goods, hardware and ironmongery | 34.460 | |
| 51.160 | Agents involved in the sale of textiles, clothing, footwear and leather goods | 62.231 | |
| 51.170 | Agents involved in the sale of food, beverages and tobacco | 59.776 | |
| 51.180 | Agents specializing in the sale of particular products or ranges of products n.e.c. | 186.455 | |
| 51.190 | Agents involved in the sale of a variety of goods | 114.594 | |
| 511P | Central food merchandizing | 752 | |
| 511U | Central non-food merchandizing | 1.759 | |
| | | | 551.577 |
| 51.211 | Wholesale of grain, seeds and animal feeds | 11.313 | |
| 51.212 | Wholesale of grain, seeds and animal feeds | 15.840 | |
| 51.220 | Wholesale of flowers and plants | 12.171 | |
| 51.231 | Wholesale of live animals | 2.821 | |
| 51.232 | Wholesale of live animals | 16.856 | |
| 51.241 | Wholesale of hides, skins, leather | 5.677 | |
| 51.242 | Wholesale of hides, skins, leather | 658 | |
| 51.250 | Wholesale of unmanufactured tobacco | 135 | |
| | | | 65.471 |
| 51.310 | Wholesale of fruit and vegetables | 43.344 | |
| 51.321 | Wholesale of butcher's meat | 9.229 | |
| 51.322 | Wholesale of meat(based) products | 2.932 | |
| 51.323 | Wholesale of poultry and game meat | 4.925 | |
| 51.331 | Wholesale of dairy produce, eggs | 11.108 | |
| 51.332 | Wholesale of edible oils and fats | 2.129 | |
| 51.341 | Wholesale of alcoholic and other beverages | 26.800 | |
| 51.342 | Wholesale of alcoholic and other beverages | 26.780 | |
| 51.350 | Wholesale of tobacco products | 857 | |
| 51.361 | Wholesale of sugar and chocolate and sugar confectionery | 367 | |
| 51.362 | Wholesale of sugar and chocolate and sugar confectionery | 6.331 | |
| 51.371 | Wholesale of coffee, tea, cocoa and spices | 3.018 | |
| 51.372 | Wholesale of coffee, tea, cocoa and spices | 497 | |
| 51.381 | Wholesale of other food including fish, crustaceans and molluscs- Commerce de gros de poissons, crustacés et mollusques | 10.958 | |
| 51.382 | Wholesale of other other food - Commerces de gros alimentaires spécialisés divers | 35.810 | |
| 51.391 | Wholesale in frozen products | 5.038 | |
| 51.392 | Non-specialized wholesale of food, beverages and tobacco | 2.640 | |
| 51.393 | Non-specialized wholesale of food, beverages and | 1.645 | |

| | | |
|---------------|----------------------------------------------------------------------------------------------------------------------------------|---------|
| | tobacco | |
| 51.394 | Non-specialized wholesale of food, beverages and tobacco | 19.559 |
| | | 213.968 |
| 51.411 | Wholesale of textiles | 12.008 |
| 51.412 | Wholesale of textiles | 7.025 |
| 51.413 | Wholesale of textiles | 9.667 |
| 51.414 | Wholesale of textiles | 2.199 |
| 51.421 | Wholesale of clothing | 71.972 |
| 51.422 | Wholesale of footwear | 8.222 |
| 51.431 | Wholesale of electrical household appliances | 8.896 |
| 51.432 | Wholesale of radio and television goods | 9.310 |
| 51.433 | Wholesale of gramophone records, tapes, CDs, DVDs and video tapes | 6.410 |
| 51.434 | Wholesale of electrical and lighting equipment | 19.920 |
| 51.441 | Wholesale of china and glassware | 3.785 |
| 51.442 | Wholesale of wallpaper and cleaning materials | 19.740 |
| 51.450 | Wholesale of perfume and cosmetics | 21.534 |
| 51.461 | Wholesale of pharmaceutical goods | 7.651 |
| 51.462 | Wholesale of pharmaceutical goods | 29.322 |
| 51.471 | Wholesale of furniture fittings/Groothandel in meubels, niet-elektrische huishoudapparaten en vloerbedekking, inclusief tapijten | 30.103 |
| 51.472 | Wholesale of newspapers, books and magazines | 34.177 |
| 51.473 | Wholesale of picture- and movieappliances and other optical appliances | 7.282 |
| 51.474 | Wholesale of watches and hourworks, of noble metal and jewelry | 9.864 |
| 51.475 | Wholesale of paperwork, office- and schoolarticles | 14.356 |
| 51.476 | Wholesale of sports- and campingarticles, bicycle(part)s, games and toys | 20.892 |
| 51.477 | Wholesale of leather- and travellinggoods | 8.536 |
| 51.478 | Other wholesale of consumerarticles, n.e.c. | 59.161 |
| | | 422.033 |
| 51.511 | Wholesale of solid, liquid and gaseous fuels and related products | 13.165 |
| 51.512 | Wholesale of solid, liquid and gaseous fuels and related products | 1.399 |
| 51.513 | Wholesale of solid, liquid and gaseous fuels and related products | 3.534 |
| 51.521 | Wholesale of metal ores | 10.524 |
| 51.522 | Wholesale of iron and steel | 516 |
| 51.523 | Wholesale of precious metals | 5.207 |
| 51.524 | Wholesale of non-ferrous metals | 991 |
| 51.531 | Wholesale of wood | 17.195 |
| 51.532 | Wholesale of paint | 61.300 |
| 51.533 | Wholesale of basic construction materials | 1.140 |
| 51.534 | Wholesale of sanitary equipment | 20.191 |
| 51.535 | Wholesale of other construction materials | 13.351 |
| 51.541 | Wholesale of hardware | 22.902 |
| 51.542 | Wholesale of plumbing and heating equipment | 23.241 |
| 51.550 | Wholesale of chemical products | 28.169 |
| 51.561 | Wholesale of industry supplies | 6.273 |
| 51.562 | Wholesale of packaging materials | 8.461 |
| 51.569 | Wholesale of intermediate products n.e.c. | 11.740 |
| 51.571 | Wholesale in car wrecks | 12.462 |
| 51.572 | Wholesale of metal waste and scrap | 3.647 |
| 51.573 | Wholesale of non-metal waste and scrap | 3.393 |
| | | 268.800 |
| 51.610/51.810 | Wholesale of machine tools | 14.241 |

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| | | |
|---------------|----------------------------------------------------------------------------------------|-----------|
| 51.620/51.820 | Wholesale of mining, construction and civil engineering machinery | 13.506 |
| 51.630/51.830 | Wholesale of machinery for the textile industry and of sewing and knitting machines | 1.920 |
| 51.640/51.840 | Wholesale of computers, computer peripheral equipment and software | 60.527 |
| 51.640/51.851 | Wholesale of other office machinery and equipment | 10.107 |
| 51.640/51.852 | Wholesale of office furniture | 11.333 |
| 51.651/51.860 | Wholesale of electronic parts | 22.287 |
| 51.652/51.871 | Wholesale of measuring and precision instruments | 14.221 |
| 51.652/51.872 | Wholesale of computerized materials handling equipment | 15.669 |
| 51.652/51.873 | Wholesale of telecommunication equipment | 24.918 |
| 51.653/51.879 | Wholesale of machinery for industry, trade and navigation n.e.c. | 82.001 |
| 51.660/51.880 | Wholesale of agricultural machinery and accessories and implements, including tractors | 22.718 |
| | | 390.831 |
| 51.700/51.901 | Other wholesale de gros spécialisés | 12.407 |
| 51.700/51.902 | Other wholesale de gros non spécialisés | 57.538 |
| | | 69.945 |
| | | 1.885.240 |

Table . VHK Company Table, section G - Retail (2005), EU-27

| Code | Description | Number | Totals |
|-------------|---------------------------------------------------------------------------------------------------------------|---------------|---------------|
| 52.112 | Non-specialized stores with food predominating | 134.199 | |
| 52.113 | Superettes (100 m ² - 400 m ²) | 50.192 | |
| 52.114 | Supermarkets (400 m ² - 2500 m ²) | 124.985 | |
| 52.115 | Hypermarkets (>2500m ²) | 15.213 | |
| 52.121 | Other department stores and the like, non-food products predominating - Grand magasins (>2500m ²) | 1.772 | |
| | | | 326.360 |
| 52.122- | Retail sale in non-specialized stores n.e.c. | 18.703 | |
| 52.210 | Greengroceries | 85.344 | |
| 52.221 | Butcher's shops - Retail sale of meat and meat products | 164.621 | |
| 52.230 | Fish-shops - Retail sale of fish, crustaceans and molluscs | 29.773 | |
| 52.241 | Bread and cake shops | 28.384 | |
| 52.242 | Sugar confectionery shops | 20.693 | |
| 52.250 | Liquor stores | 31.807 | |
| 52.260 | Tobacconist's shops | 91.998 | |
| 52.271 | Retail sale of dairy products | 15.977 | |
| 52.272 | Retail sale of health foods | 29.076 | |
| 52.273 | Retail sale of foreign food | 13.442 | |
| 52.274 | Retail sale of food in specialized stores n.e.c. | 9.002 | |
| | | | 538.820 |
| 52.310 | Dispensing chemists | 120.719 | |
| 52.320 | Shops for medical and orthopaedic goods | 14.180 | |
| 52.330 | Shops for cosmetic and toilet articles | 66.618 | |
| 52.410 | Textile stores | 49.945 | |
| | | | 251.462 |
| 52.421 | Stores for men's, women's and children's clothing, mixed | 246.118 | |
| 52.422 | Stores for men's clothing | 33.826 | |
| 52.423 | Stores for women's clothing | 83.172 | |
| 52.424 | Stores for children's clothing | 51.746 | |
| 52.425 | Stores for underwear, lingerie and swimwear | 4.181 | |
| 52.426 | Stores for clothing accessories | 3.404 | |
| 52.431 | Shoe stores | 72.373 | |
| 52.432 | Leather goods stores | 18.574 | |
| 52.441 | Stores for furniture | 86.986 | |
| 52.442 | Stores for home furnishing textiles | 52.915 | |
| 52.443 | Stores for glassware, china and kitchenware | 22.522 | |
| 52.444 | Stores for lighting equipment | 4.650 | |
| 52.445 | Stores for household appliances n.e.c. | 17.408 | |
| 52.451 | Stores for electrical household appliances | 44.197 | |
| 52.452 | Radio and television stores | 29.135 | |
| 52.453 | Stores for gramophone records, tapes, CDs, DVDs and video tapes | 13.422 | |
| 52.454 | Stores for musical instruments and music scores | 6.046 | |
| 52.455 | Stores for sewing and knitting machines | 3.518 | |
| 52.461 | Stores for hardware, plumbing and building materials | 94.522 | |
| 52.462 | Do-it-yourself / paint stores | 37.982 | |
| 52.471 | Stores for books and stationery | 21.305 | |
| 52.472 | Stores for newspapers and magazines | 68.305 | |
| 52.473 | Stores for books/stationery/newspapers/magazines n.e.c. | 68.519 | |
| 52.481 | Opticians | 26.665 | |
| 52.482 | Stores for photographic equipment and related services | 51.624 | |
| 52.483 | Stores for watches and clocks | 73.828 | |
| 52.484 | Stores for jewellery, gold wares and silverware | 17.344 | |
| 52.485 | Stores for sports and leisure goods | 89.440 | |
| 52.486 | Toy stores | 20.820 | |

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| | | |
|--------|--------------------------------------------------------------------------------------------------------------------|-----------|
| 52.487 | Florist's shops | 63.989 |
| 52.488 | Pet shops | 7.070 |
| 52.489 | Retail trade of coal and fuels | 6.131 |
| 52.491 | Art dealers and galleries | 44.288 |
| 52.492 | Coins and stamps shops | 5.070 |
| 52.493 | Stores for computers, office machinery and computer programmes | 60.837 |
| 52.494 | Stores for telecommunication equipment | 16.022 |
| 52.495 | Stores for wallpaper, carpets, rugs and floor coverings | 6.474 |
| 52.496 | Stores for boats and boating accessories | 29.510 |
| 52.497 | Stores for office furniture | 861 |
| 52.499 | Specialized stores n.e.c. | 70.689 |
| | | 1.675.487 |
| 52.501 | Antiques shops and second-hand book stores | 59.025 |
| 52.502 | Stores for other second-hand goods | 23.007 |
| 52.611 | Non-specialized mail order houses | 6.078 |
| 52.612 | Mail order houses for textiles and clothing | 3.931 |
| 52.613 | Mail order houses for sports and leisure goods | 2.808 |
| 52.614 | Mail order houses for books and other media goods | 3.089 |
| 52.615 | Mail order houses for household goods | 2.246 |
| 52.616 | Other mail order houses | 7.051 |
| 52.618 | Non-specialized retail sale via internet and retail sale of books, media goods and computer equipment via internet | 8.579 |
| 52.619 | Other retail sale via internet | 6.864 |
| 52.621 | Retail sale via food stalls and market stands | 107.549 |
| 52.629 | Other stalls and market stands | 232.856 |
| 52.631 | Retail sale on commission | 31.852 |
| 52.632 | Ambulatory and occasional retail sale of food | 15.166 |
| 52.633 | Ambulatory and occasional retail sale of other goods | 33.209 |
| 52.639 | Non-store retail sale n.e.c. | 55.718 |
| 52.710 | Repair shops for boots, shoes and other articles of leather | 27.152 |
| 52.720 | Repair shops for electrical household goods and bigger electrical goods | 49.605 |
| 52.730 | Repair shops for watches, clocks and jewellery | 8.977 |
| 52.740 | Repair shops n.e.c. | 51.564 |
| | | 736.327 |
| | | 3.528.456 |

Table . VHK Company Table, section K - Real estate, renting and business activities (2005), EU-27

| Code | Description | Number | Totals |
|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|---------|-----------|
| K - Real estate, renting and business activities | | | |
| 70.111 | Development and selling of dwellings | 67.009 | |
| 70.112 | Development and selling of offices | 3.306 | |
| 70.113 | Development and selling of d'infrastructures | 27.647 | |
| 70.114 | Legal support for building plans | 18.956 | |
| 70.120 | Buying and selling own real estate | 235.137 | |
| 70.201-70.209 | Letting own real estate | 393.123 | |
| 70.310 | Real estate agencies | 219.325 | |
| 70.321 | Management departments of national cooperative building societies | 27.891 | |
| 70.329 | Other co for real estate management on a fee or contract basis | 16.601 | |
| 703E | Legal support for the management of holdings | 13.166 | |
| total | | | 1.022.162 |
| 71.100 | Short automobile renting companies | 16.315 | |
| 71.100 | Long Automobile renting companies | 5.182 | |
| 71.210 | Renting other land transport equipment | 11.358 | |
| 71.220 | Renting water transport equipment | 2.954 | |
| 71.230 | Renting air transport equipment | 2.124 | |
| 71.310 | Renting agricultural machinery and equipment | 34.051 | |
| 71.320 | Renting construction and civil engineering machinery and equipment | 11.535 | |
| 71.330 | Renting office machinery and equipment including computers | 2.570 | |
| 71.340 | Renting other machinery and equipment n.e.c. | 26.025 | |
| 71.401+71.402 | Video and DVD film renting and renting of other personal and household goods n.e.c. | 42.386 | |
| total | | | 154.500 |
| 72.100 | Hardware consultancy | 42.890 | |
| 72.210 | Publishers of software | 53.183 | |
| 72.220 | Other software consultancy | 205.812 | |
| 72.300 | Data processing | 58.556 | |
| 72.400 | Data base activities | 12.812 | |
| 72.500 | Maintenance & repair of office, accounting and computing machinery | 35.850 | |
| 72.601 | Other computer related activities | 12.501 | |
| 72.602 | Other computer related activities | 74.169 | |
| total | | | 495.774 |
| 73.101 | Research and development on natural sciences | 3.392 | |
| 73.102 | Research and development on engineering and technology | 10.428 | |
| 73.103 | Research and development on medical and pharmaceutical sciences | 17.038 | |
| 73.104+73.105 | Research and development on agricultural sciences and interdisciplinary R&D, predominantly on natural sciences and engineering | 1.530 | |
| 73.201 | Research and development on social sciences | 18.251 | |
| 73.202 | Research and development on humanities | 8.017 | |
| 73.203 | Interdisciplinary research and development, predominantly on social sciences and huma | 1.535 | |
| total | | | 60.191 |
| 74.111 | Solicitor's firms | 335.218 | |
| 74.112 | Patent and copyright agencies | 28.038 | |
| 74.121 | Bookkeeping | 264.118 | |
| 74.122 | Firms of accountants | 900 | |

| | | |
|----------------------|----------------------------------------------------------------|------------------|
| 74.123 | Company revisors (accountants) and taxation consultants | 2.765 |
| 74.130 | Market research and public opinion polling | 26.915 |
| 74.141 | Business and management consultancy | 54.578 |
| 74.142-74.146 | Other business and management consultancy | 433.620 |
| 74.150 | Holding companies | 219.962 |
| 74.201 | Architects offices | 260.318 |
| 74.202 | Land surveyors | 85.894 |
| 74.203-206 | Technical studies and engineering activities | 394.602 |
| 74.301 | Companies for technical testing and analysis of cars | 24.766 |
| 74.302 | Companies for other technical testing and analysis | 21.053 |
| 74.401 | Advertising agencies | 92.309 |
| 74.402 | Advertisement placement agencies | 20.419 |
| 74.403 | Advertising material delivery | 7.517 |
| 74.409 | Other advertising and marketing | 44.817 |
| 74.501 | Labour and personnel recruitment offices | 15.695 |
| 74.502 | Provision of personnel companies | 15.425 |
| 74.601 | Investigation and security service | 37.824 |
| 74.602 | Investigation and security service | 24.754 |
| 74.701 | Cleaning companies | 144.709 |
| 74.702 | Disinfecting and exterminating services | 11.561 |
| 74.703 | Chimney sweeps | 7.942 |
| 74.811 | Portrait photographers | 37.164 |
| 74.812 | Advertising photographers | 32.787 |
| 74.813 | Press and other photographers | 44.995 |
| 74.814 | Photographic laboratories | 9.918 |
| 74.821 | Packaging companies | 2.392 |
| 74.822 | Packaging companies | 7.942 |
| 74.831/74.851 | Secretariats | 41.607 |
| 74.832/74.852 | Translation services and interpreters | 55.230 |
| 74.833/74.853 | Mail treatment | 24.569 |
| 74.834/74.854 | Social secretariats | 46.114 |
| 74.835/74.855 | Other administrative activities, n.e.c. | 4.856 |
| 74.841/74.871 | Auctions | 79.368 |
| 74.842/74.872 | Exhibition, trade fair, congress and day conference activities | 70.519 |
| 74.843/74.873 | Debt collecting and credit rating activities | 5.488 |
| 74.844/74.874 | Graphical inhouse design | 14.869 |
| 74.849/74.879 | Other business services, n.e.c. | 296.920 |
| 74.860 | Call centres | 9.025 |
| total | | 3.359.483 |
| TOTAL GROUP K | | 5.092.110 |

ANNEX II

Special ventilation applications out-of-scope of Lot 6

OPERATING ROOMS (OR, in hospitals)

EU average 2005: 590 beds per 100.000 inhabitant → EU27: 450 million inhabitants → 2,7 million hospital beds.

Per bed ca. 20 m² → 54 million m² hospital surface → 150-200 million m³. Effective 18 oC → +50% (because warmer and 24/7) ca. 300 million m³

Compare: Total health care 4,9% of 110 billion m³ @ 18oC = 5,4 billion m³

So hospitals are ca. 6% of all health care in terms of heated volume @ 18 oC → 0,3% of total 18oC volume in EU27.

Treatment centres (OR plus services): 15% of hospital surface/volume → 8,1 mln. M². Typically between 120 and 155 m² per OR (including pre- and post op as well as general service areas) → 60 000 operating rooms → total 25 mln. m³.

Ventilation requirements: OR(operating area) ventilation 20 m³/m³; Pre- and post op 10 m³/m³; other service 6 m³/m³. Average 10 m³/m³ → 10 x normal ventilation → operating centres are responsible for more than half of ventilation losses of the whole hospital or rather, the OR more than doubles the heating requirements per m³ of a hospital → hospitals at least some 12% of total health care ventilation heating requirements (instead of 6% which would be proportional to their volume and average temperature) → all in all, not including the operating rooms Lot 6 misses out on 0,3% of ventilation losses of all buildings and around 1% in the tertiary sector.

CLEANROOMS

2002 data on clean rooms in pharmaceutical industry only (=ca. 23-25% of all clean rooms)

UK 45 000 m² (4900 staff); DE 72 000 m²; FR 65 700 m²; IT 40 000 m² → total 220.000 m². Rest of EU is much lower but estimate 180 000 m² → total 400 000 m² pharmaceutical cleanrooms → 1,6 mln. m² cleanrooms in EU27. → ca. 5-6 mln. m³. Assume ventilation fold also 10 m³/m³ → 50 mln. m³.

This is 0,04% of the total heated building volume @ 18oC of all buildings and around 0,2-0,3% of the industrial buildings.

INING

In the EU-27 there are probably only a few 100 operational deep mines that would require special ventilation provisions for mining personal working underground. Many mines are surface mines (quarrying, opencast pit) and most deep mines extract ores fully mechanized (e.g. long-walling), requiring only a minimum workforce of machine operators.

Even if these mines would require an unlikely volume of 10 000 m³ to be ventilated at 10 m³/m³ the total equivalent volume for 100 mines would not amount to more than 10 mln. m³, which is less than 0,01% of the EU27 total. Even allowing for some 500 mines this would not be more than 0,05% of EU27 total.

VENTILATION REQUIREMENTS

The ventilation requirements of clean rooms and operating theatres are completely different from those in normal dwellings. They require high ventilation folds, high filtration (HEPA, ULPA), special system layouts (e.g. down-flow laminar flow ceilings with overpressure system in OR), air locks, etc.. The difference with normal ventilation in terms of performance can most clearly be illustrated by the case of clean rooms, which can be classified e.g. according to the number and size of particles permitted per volume of air. "Class 100" denotes that 100 particles of size 0.5 µm at most are permitted per cubic foot of air. "Class 1000" or even "class 10,000" allow accordingly more particles of size 0.5 µm per cubic foot of air. For comparison, the ambient air outside in an urban environment contains approximately 35,000,000 particles of size 0.5 µm or larger per cubic metre. Clean rooms are known from the electronics industry (chip-manufacturing), but also widespread in all sorts of laboratories dealing with critical substances.

The case of mining ventilation is still a different one, characterised by high and critical levels of pollution. The air flow much reach sufficiently high levels to dilute and remove noxious gases (typically NO_x, SO₂, methane, CO₂ and CO) and particles. The source of these gases are equipment that runs on diesel engines, blasting and the orebody itself. Ventilation may be required to cool the ambient temperature in a deep hot mine. Alternatively in temperate climates it may be heated in winter time. Ventilation electricity consumption may constitute up to one third of total mining electricity consumption.

POTENTIAL MISSED BY EXCLUDING FROM THE SCOPE

Very likely, the saving potential of waste heat recovery and better controls for clean rooms, operating rooms and mining will be substantial, as they are relatively large energy consumers in their sector. However, the applications are far too critical –literally a matter of life and death—and bound by specific boundary conditions to be regulated through generic EU measures.

In the scope document, it is estimated that these –and other—special ventilation applications that are not taken into account represent around 1,7% of the total. Even though the estimates in this memo are very approximate, they confirm that this is still a fair estimate.

Some sources:

<http://pharmtech.findpharma.com/pharmtech/Aseptic+Equipment/The-Clean-Room-Technology-Market-in-the-European-P/ArticleStandard/Article/detail/52262>

<http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&language=en&pcode=tps00046&plugin=0&tableSelection=1&footnotes=yes&labeling=labels>

http://ec.europa.eu/health/ph_information/dissemination/hsis/hsis_11_en.htm

www.euracoal.be

www.euromines.org

ANNEX III

Buildings and heat loads

Main Building Types by Normalized Heated Volume

(total 110 bln. m³ @ 18 oC indoors)

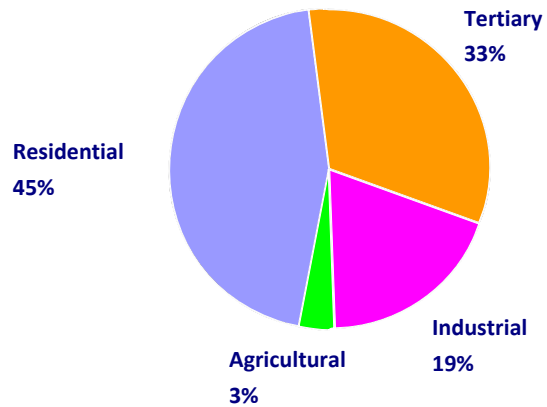


Fig. 3

Average indoor temperatures (weekly 24/7 average)

- Hospitals, hotels 20 °C
- Dwellings 18 °C
- Offices 17,5 °C
- Industrial, schools, greenhouses 16-16,5 °C
- Second homes 13 °C
- Churches 11 °C
- Etc.

Correction: Every degree difference from 18 °C = 8% less/more (6-7 °C average heating season temperature)

Fig. 4

Table .Estimated EU-25 unheated building floor area (2003)

| | mln. m ² | mln. # |
|-----------------------------------------------|---------------------|--------|
| | 31.500 | 45,00 |
| Private garages (50%) | 2.250 | 50,00 |
| Second homes (50%) | 1.105 | 17,00 |
| Primary dwellings (5%) | 870 | 10,00 |
| Churches (70%) | 840 | 0,42 |
| Unheated transport building floor (70%) | 750 | 0,30 |
| Energy, water, waste plants | 700 | 1,00 |
| Warehouses (66% of #, 38% of m ²) | 259 | 0,37 |
| Unheated industrial floor* (25%) | 210 | 0,30 |
| Parking building | 100 | 0,04 |
| Unheated shop/rest. floor* (20%) | 20 | 1,00 |
| Petrol stations* (30%) & street kiosks (100%) | 2 | 0,13 |
| Greenhouses (50%) | 522 | 0,10 |
| | 39.128 | 126 |


 =To be corrected

Fig. 5

Tertiary sector buildings by NUMBER (in %)

(4,74 mln. units)

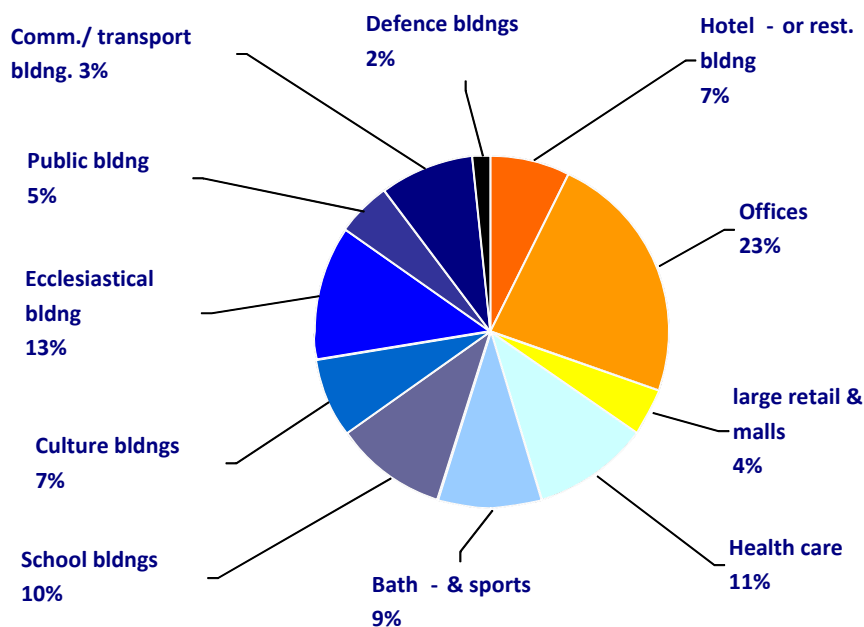


Fig. 11

Tertiary sector buildings by Normalized Heat Volume
 (36 bln. m³ @ 18 oC indoors)

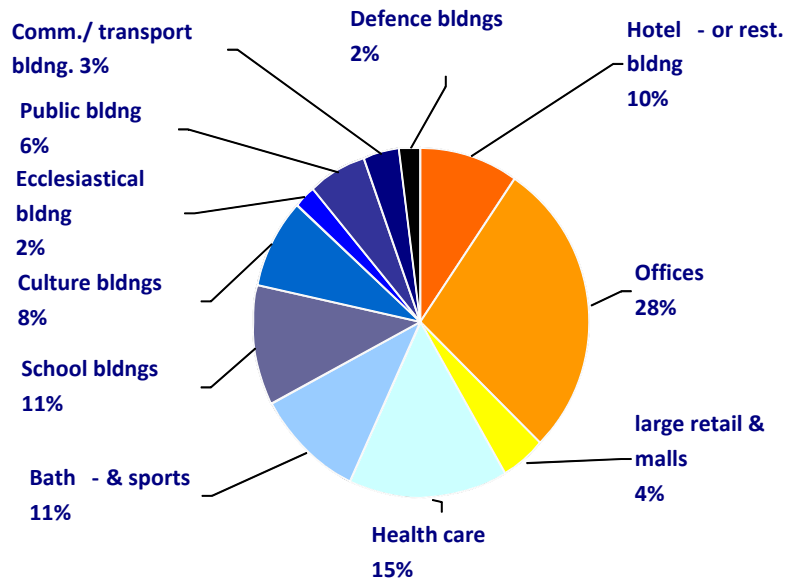


Fig. 12

Compare: Space heating energy, tertiary sector NL
 (source ECN 1999)

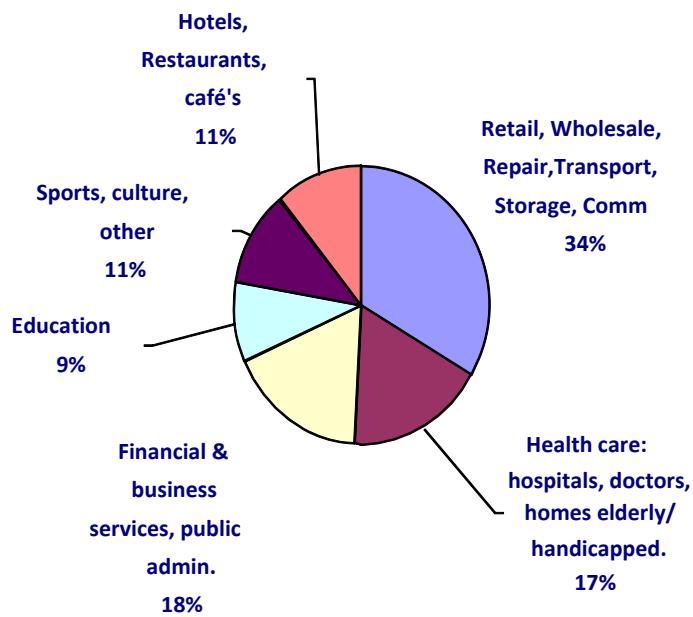


Fig. 13a

**Norway heating energy,
service sector 2000**

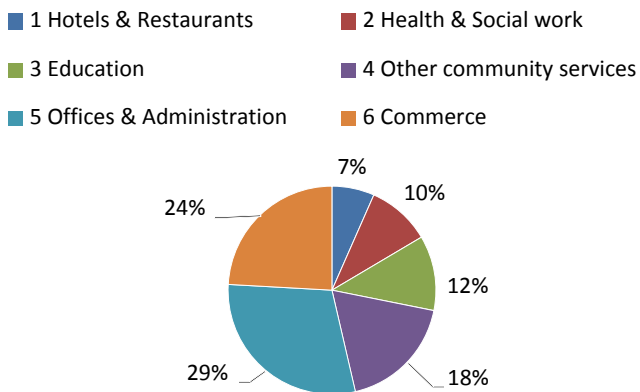


Fig. 13b

Industrial etc. units, Normalized Heated Volume
(24 bln. M³ @ 18 oC indoors)

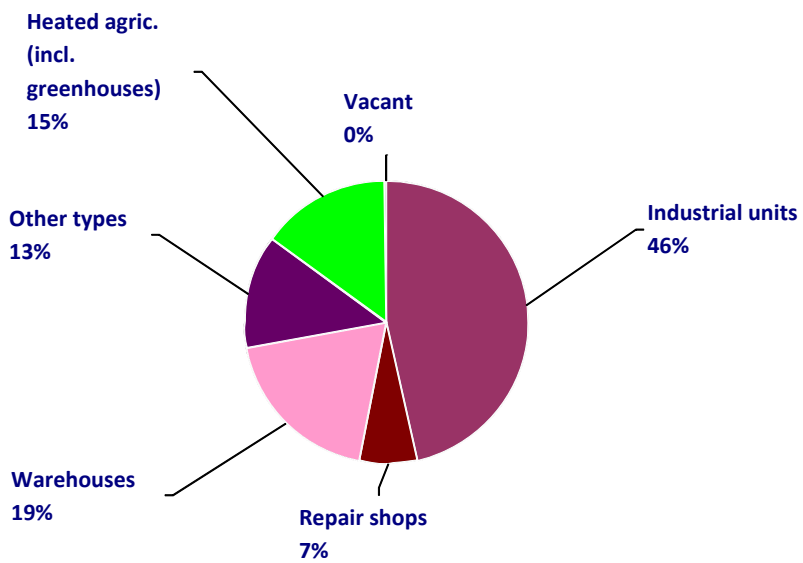


Fig. 15

CHECK with ECCP

- In ECCP apparently industry under-valued, but consider that 0,3 mln. repair shops (garages) and 0,55 mln. warehouses (5% of total, 30% of 'industrial buildings') are defined as 'tertiary' in ECCP → smaller difference 8 vs. 14%
- In ECCP apparently tertiary OK, but consider not only 5% above but also 1,3% of shops, restaurants, etc. in residential sector → tertiary at 39%
- In ECCP residential higher (59 vs. 44-45%) but part of difference may be caused by housing definition e.g. retirement homes are in some MS residential and not tertiary.

Fig. 16

Preparatory study Lot 1, Task3

Table. EU Housing Characteristics 2003 (source: VHK compilation of 'Housing Statistics of the European Union 2004', Boverket 2005)

| Parameter | unit | EU-25 | A | B | CY | CZ | DK | EST | FIN | F | D | GR | H | IRL | IT | LT | LIT | LUX | MT | NL | PL | P | SK | SLO | E | S | UK |
|---------------------------------------|-------------------|--------|------|------|------|------|------|-----|------|-------|-------|------|------|------|-------|-----|------|-----|-----|------|-------|------|------|-----|-------|------|-------|
| 1. Dwelling stock** | k# | 204663 | 3280 | 4820 | 299 | 4366 | 2561 | 624 | 2574 | 29495 | 38925 | 5465 | 4134 | 1554 | 26526 | 967 | 1292 | 176 | 127 | 6811 | 11764 | 5318 | 1885 | 785 | 20947 | 4351 | 25617 |
| 2 Primary (= ca. # households) | k# | 184166 | 3280 | 4325 | 239 | 4216 | 2481 | 566 | 2378 | 24525 | 38944 | 3674 | 3863 | 1382 | 22004 | 915 | 1346 | 171 | 129 | 6996 | 13337 | 3651 | 2072 | 685 | 14187 | 4454 | 24346 |
| 3 Secondary | k# | 20497 | 0 | 495 | 60 | 150 | 80 | 58 | 196 | 4970 | -19 | 1791 | 271 | 172 | 4522 | 52 | -54 | 5 | -2 | -185 | -1573 | 1667 | -187 | 100 | 6760 | -103 | 1271 |
| 4 Secondary types, included in | | | WSV | WSC | WS | SVN | V | na | SVN | WSH | S | WSV | WSV | WSm | WSV | WV | CN | CHM | WSN | V- | SCH | WS | V | WSV | WS | CV | WSV |
| 5 Vacant dwellings | k# | 18083 | | na | 72 | 537 | 128 | 68 | 237 | 2006 | 3192 | 514 | 347 | 182 | 5199 | 58 | 48 | 4 | na | 150 | 623 | 564 | 219 | 79 | 2912 | 74 | 871 |
| 6 One/two family dwellings | % | 54 | 48 | 75 | na | 44 | 61 | 32 | 42 | 57 | 46 | 59 | 66 | 91 | 25 | 29 | 39 | 71 | na | 69 | 37 | 77 | 49 | 72 | 53 | 48 | 81 |
| 7 Multi-family dwellings | % | 46 | 52 | 25 | na | 57 | 39 | 68 | 58 | 43 | 54 | 41 | 34 | 9 | 75 | 71 | 61 | 29 | na | 31 | 63 | 23 | 52 | 28 | 48 | 52 | 19 |
| 8 of which high-rise (> 4 storeys), | % | 16 | na | 4 | na | 34 | 10 | na | na | 16 | 6 | na | 23 | na | 23 | na | na | 16 | na | 7 | 39 | 22 | 38 | 12 | 31 | na | 2 |
| 9 New built 2003 (completed) | k# | 2174 | 42 | 41 | 6 | 27 | 24 | 2 | 28 | 334 | 268 | 128 | 22 | 69 | 178 | 1 | 5 | 2 | na | 60 | 163 | 82 | 14 | 7 | 459 | 24 | 190 |
| 10 New built 1990 (completed) | k# | 2169 | 42 | 43 | 8 | 45 | 27 | 8 | 65 | 336 | 319 | 120 | 44 | 20 | 176 | 13 | 22 | 3 | na | 101 | 134 | 66 | 25 | 8 | 281 | 58 | 205 |
| 11 Demolished/removed | k# | 133 | 16 | 2 | 0 | 2 | 8 | 1 | 3 | 21 | 22 | na | 5 | 11 | na | 3 | 0 | na | na | 18 | 5 | 1 | 1 | 0 | 16 | 2 | 15 |
| 12 Year of built <1919 [VHK 1880] | % | 15 | 19 | 15 | na | 11 | 20 | 9 | 2 | 20 | 15 | 3 | 14 | 10 | 19 | 11 | 6 | 12 | 15 | 7 | 10 | 6 | 3 | 15 | 9 | 12 | 21 |
| 13 Year of built 1919–1945 | % | 12 | 8 | 17 | 7 | 15 | 17 | 14 | 9 | 13 | 13 | 7 | 13 | 8 | 11 | 14 | 23 | 15 | 11 | 13 | 13 | 9 | 7 | 8 | 4 | 20 | 18 |
| 14 Year of built 1946–1970 | % | 32 | 27 | 29 | 17 | 26 | 28 | 30 | 31 | 18 | 47 | 32 | 26 | 16 | 41 | 28 | 33 | 27 | 29 | 31 | 27 | 23 | 35 | 28 | 34 | 33 | 21 |
| 15 Year of built 1971–1980 | % | 20 | 16 | 15 | 21 | 23 | 18 | 22 | 23 | 26 | 11 | 25 | 22 | 18 | 20 | 23 | 18 | 15 | 17 | 19 | 18 | 18 | 26 | 24 | 24 | 17 | 22 |
| 16 Year of built >1980 | % | 22 | 12 | 9 | 27 | 16 | 10 | 20 | 20 | 10 | 15 | 19 | 18 | 16 | 10 | 21 | 14 | 12 | 16 | 30 | 19 | 44 | 21 | 16 | 14 | 10 | 19 |
| 17 of which, year of built >1990 | % | 13 | 18 | 15 | | 8 | 7 | 5 | 14 | 12 | | 14 | 7 | 32 | | 4 | 6 | 17 | 12 | | 13 | | 7 | 9 | 16 | 7 | |
| 18 Avg. age dwellings [VHK est.] | yr | 49 | 49 | 50 | 28 | 46 | 57 | 45 | 33 | 52 | 53 | 35 | 48 | 35 | 56 | 46 | 47 | 45 | 48 | 40 | 43 | 33 | 36 | 47 | 39 | 52 | 56 |
| 19 Floor area/dwelling (stock) | m ² | 87 | 94 | 86 | 145 | 76 | 109 | 60 | 77 | 90 | 90 | 83 | 75 | 104 | 90 | 55 | 61 | 125 | 106 | 98 | 68 | 83 | 56 | 75 | 90 | 92 | 87 |
| 20 Floor area/dwelling (new 2003) | m ² | 103 | 101 | 119 | 198 | 105 | 112 | 89 | 90 | 113 | 114 | 125 | 94 | 105 | 82 | 194 | 106 | 120 | 106 | 116 | 99 | 89 | 118 | 114 | 96 | 128 | 83 |
| 21 Floor area/person (stock) | m ² | 35 | 38 | 36 | 48 | 29 | 51 | 28 | 36 | 38 | 40 | 30 | 28 | 35 | 35 | 24 | 23 | 50 | 34 | 41 | 22 | 30 | 26 | 30 | 31 | 44 | 44 |
| 22 Number of rooms (stock) | # | 4,0 | 4,1 | 4,3 | 5,4 | 2,9 | 3,8 | 3,6 | 3,6 | 4 | 4,4 | 3,8 | na | 5,6 | 4,1 | 2,4 | 2,5 | 5,5 | na | 4,2 | 3,7 | 4,3 | 3,2 | 2,8 | 5 | 4,2 | 4,7 |
| 23 Number of rooms (new built) | # | 4,5 | 3,5 | 5,8 | 6,1 | 3,9 | 3,4 | 4 | 3,8 | 3,9 | 5,1 | 3,1 | 4 | 5,6 | 3,8 | 4,3 | 3,5 | 5,2 | na | 3,9 | 4,2 | 4,9 | 3,1 | 3,4 | 5,4 | 4,2 | 4,5 |
| 24 persons/household (stock) | # | 2,5 | 2,4 | 2,4 | 3 | 2,4 | 2,2 | 2,4 | 2,2 | 2,4 | 2,1 | 2,8 | 2,6 | 2,9 | 2,6 | 2,5 | 2,6 | 2,5 | 3 | 2,3 | 2,8 | 2,8 | 2,6 | 2,8 | 2,9 | 1,9 | 2,4 |
| 25 Central heating (wet & dry) | % | 79 | 90 | 73 | 27 | 82 | 92 | 59 | 92 | 91 | 91 | 64 | 53 | 59 | 79 | 65 | 72 | 92 | 3 | 90 | 78 | 4 | 74 | 79 | 42 | 100 | 94 |
| 26 Bath/shower (hot water) | % | 78 | 98 | 96 | 99 | 96 | 95 | 67 | 99 | 98 | | 98 | 87 | 94 | 99 | 67 | 70 | 94 | 100 | 100 | 87 | 66 | 93 | 92 | 99 | 100 | 99 |
| 27 solar sys.penetration, % dwell.*** | % | 2,5 | 11,8 | 0,5 | 66,9 | 0,3 | 2,6 | 0,0 | 0,1 | 0,4 | 3,4 | 22,3 | 25,4 | 0,2 | 0,6 | 0,1 | 0,0 | 1,5 | 6,0 | 1,5 | 0,2 | 1,2 | 0,7 | 2,6 | 0,8 | 1,0 | 0,3 |
| 28 solar collector stock*** | 000m ² | 15573 | 2318 | 68 | 500 | 66 | 337 | 1 | 14 | 396 | 6554 | 3047 | 5250 | 11 | 516 | 3 | 2 | 13 | 19 | 304 | 138 | 161 | 64 | 102 | 527 | 208 | 197 |
| 29 estimated collect area/hh | m ² | 3 | 6 | 3 | 2,5 | 5 | 5 | 5 | 5 | 3 | 5 | 2,5 | 5 | 3 | 3 | 5 | 5 | 5 | 2,5 | 3 | 5 | 2,5 | 5 | 5 | 3 | 5 | 3 |
| 30 total solar collector sales 2005 | 000m ² | 2073 | 240 | 28 | 50 | 19 | 21 | 0 | 2 | 164 | 980 | 221 | 1 | 4 | 72 | 1 | 1 | 2 | 4 | 39 | 28 | 16 | 7 | 5 | 107 | 35 | 28 |
| 31 of which glazed collector sales | % | 89 | 97 | 73 | 100 | 70 | 99 | 100 | 100 | 93 | 87 | 100 | 100 | 100 | 96 | 100 | 100 | 100 | 100 | 48 | 85 | 97 | 88 | 94 | 95 | 49 | 64 |
| 32 unglazed coll. sales | % | 4 | 3 | 27 | | 17 | | | | 4 | 3 | | | | | | | | | 52 | 0 | | | | | | |
| 33 vacuum tube sales | % | 6 | 1 | | | 13 | 1 | | | 3 | 10 | | | | 4 | | | | | | 15 | 3 | 12 | 6 | 5 | 16 | 36 |

* = W=Winter or summer habitation; S=Second homes; C=Collective homes; H=Hotels; M=Trailers & ships; m=Trailers; V=Vacant homes; N=Non-permanent habitation; na= no data available; | = data included in line above;
**= dwelling stock data year CY: 2002; FI: 2001; FR: 2002; GR:2001; HU: 2001; LU: 2002; MT: 1983; PL: 2002. PT: 1999 most recent, 2003 is estimate; In other lines, italic font indicate older reference years
***= solar sales and stock data from ESTIF (www.estif.org). Collector area per household estimated by VHK on the basis of general recommendations by authorities for 4-person household.

Table . EU Tertiary Sector Heat Load Assessment (VHK 2006)

| Parameter | unit | EU-25 | AT | BE | CY | CZ | DK | EE | FI | FR | DE | EL | HU | IE | IT | LV | LT | LU | MT | NL | PL | PT | SK | SI | ES | SE | UK | |
|-------------------------------------------------------------------------------|--------------------------------|--------|------|------|-----|------|------|-----|------|-------|-------|------|------|------|-------|-----|-----|-----|-----|-------|-------|------|------|-----|-------|------|-------|--|
| <u>Base data 2003 (Ecoheatcool vs. VHK)</u> | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Ecoheatcool est. floor area | m ^{ln} m ² | 6310 | 119 | 151 | 7 | 100 | 114 | 14 | 101 | 861 | 1852 | 149 | 101 | 58 | 453 | 23 | 14 | 7 | 4 | 183 | 382 | 126 | 81 | 16 | 341 | 161 | 892 | |
| VHK est.heat. floor area | m ^{ln} m ² | 4655 | 80 | 114 | 7 | 100 | 70 | 7 | 70 | 800 | 1000 | 121 | 80 | 44 | 450 | 12 | 10 | 5 | 4 | 270 | 200 | 80 | 35 | 16 | 340 | 90 | 650 | |
| <u>Tertiary Energy Consumption in ktoe (1 toe=41,86 GJ= 11627 kWh) PRIMES</u> | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PRIMES 2003 (calc.) | ktoe | 167810 | 3228 | 4344 | 156 | 4179 | 2900 | 419 | 3542 | 26883 | 33506 | 2835 | 3847 | 2000 | 15493 | 674 | 623 | 140 | 55 | 12078 | 10553 | 2475 | 1371 | 681 | 10030 | 5570 | 20228 | |
| Eurostat 2003 | ktoe | 129156 | 2802 | 3837 | 140 | 3483 | 1959 | 344 | 1717 | 24923 | 23994 | 1663 | 3055 | 1708 | 13483 | 569 | 527 | 95 | 55 | 7587 | 6237 | 1979 | 1146 | 236 | 6962 | 4713 | 15942 | |
| <u>Tertiary sector kWh/floor area (VHK/Eurostat)</u> | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| kWh per m ² tertiary | kWh/m ² | 323 | 407 | 392 | 233 | 405 | 325 | 571 | 285 | 362 | 279 | 160 | 444 | 455 | 348 | 551 | 613 | 224 | 146 | 327 | 363 | 288 | 381 | 171 | 238 | 609 | 285 | |
| compare: | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| kWh per m ² residential '03 | kWh/m ² | 180 | 259 | 264 | 82 | 193 | 171 | 288 | 292 | 171 | 212 | 129 | 220 | 187 | 137 | 252 | 201 | 320 | 72 | 177 | 250 | 79 | 171 | 230 | 79 | 215 | 225 | |
| <u>Tertiary heating share of total kWh/floor area (excl. cooling)</u> | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| kWh per m ² tertiary | kWh/m ² | 197 | 248 | 239 | 70 | 247 | 198 | 349 | 350 | 221 | 170 | 97 | 271 | 278 | 213 | 336 | 374 | 137 | 60 | 186 | 221 | 175 | 232 | 105 | 145 | 371 | 174 | |
| compare: | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| kWh per m ² residential | kWh/m ² | 145 | 195 | 237 | 44 | 166 | 124 | 276 | 231 | 139 | 174 | 123 | 159 | 167 | 99 | 242 | 160 | 225 | 22 | 112 | 171 | 41 | 155 | 208 | 60 | 152 | 164 | |
| <u>Tertiary heating load kWh/floor area (excl. Cooling)</u> | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| kWh per m ² tertiary | kWh/m ² | 117 | 144 | 142 | 51 | 155 | 127 | 235 | 240 | 128 | 98 | 55 | 154 | 168 | 117 | 207 | 239 | 75 | 42 | 102 | 134 | 109 | 139 | 62 | 91 | 289 | 100 | |
| compare: | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| kWh per m ² residential | kWh/m ² | 86 | 113 | 141 | 32 | 104 | 79 | 186 | 158 | 80 | 100 | 69 | 90 | 101 | 54 | 149 | 102 | 123 | 16 | 61 | 104 | 25 | 93 | 124 | 37 | 118 | 94 | |

Table 3.a. EU Services sector: Energy consumption for space heating and hot water 1995-1999 (source: VHK compilation of Eurostat 2002) in TJ (Terajoules)

| Parameter | unit | EU-25 | AT | BE | CY | CZ | DK | EE | FI | FR | DE | EL | HU | IE | IT | LV | LT | LU | MT | NL | PL | PT | SK | SI | ES | SE | UK* |
|--------------------------------------------------------------------------------|------|-------|-------|----|----|------|----|------|-------|--------|------|----|----|----|--------|----|----|----|----|----|----|------|----|-----|------|-------|-------|
| 1. Hotels and Restaurants (NACE 55) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Consumption per m ² (MJ/m ²) | | - | - | - | - | 320 | - | 791 | 785 | 821 | na | - | - | - | - | - | - | - | - | - | - | - | - | 624 | 518 | - | - |
| Heating Oil | TJ | 3557 | 2213 | - | - | 319 | - | 973 | 15324 | 28002 | 2512 | - | - | - | 16440 | - | - | - | - | - | - | 1239 | - | - | 1356 | 12 | 32200 |
| Natural gas | TJ | 885 | 6708 | - | - | 452 | - | 66 | 19620 | 24679 | 0 | - | - | - | 60041 | - | - | - | - | - | - | - | - | - | 639 | 63 | 79300 |
| LPG and Manuf. gas | TJ | 337 | 113 | - | - | 109 | - | na | na | 1965 | 494 | - | - | - | 16014 | - | - | - | - | - | - | 4007 | - | - | 168 | na | - |
| Solid fuels | TJ | na | - | - | - | - | - | na | na | 2200 | 6099 | - | - | - | na | - | - | - | - | - | - | - | - | - | 2 | na | 600 |
| Electricity | TJ | 2072 | 144 | - | - | 233 | - | 486 | 8114 | 8319 | 0 | - | - | - | 2758 | - | - | - | - | - | - | 442 | - | - | 468 | 540 | 3200 |
| District heating | TJ | 476 | - | - | - | 1054 | - | 1896 | - | - | - | - | - | - | 14524 | - | - | - | - | - | - | - | - | - | - | 1508 | - |
| Other | TJ | 1179 | - | - | - | - | - | 87 | 5101 | 9652 | 109 | - | - | - | 463 | - | - | - | - | - | - | - | - | - | 0 | 197 | - |
| TOTAL | TJ | 8506 | 9178 | - | - | 2167 | - | 3508 | 48159 | 74817 | 9214 | - | - | - | 110240 | - | - | - | - | - | - | 5688 | - | - | 2633 | 3508 | - |
| 2. Health & social work (NACE 85) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Consumption per m ² (MJ/m ²) | | - | na | - | - | 648 | - | 980 | 691 | 731 | na | - | - | - | - | - | - | - | - | - | - | - | - | - | 343 | 579 | - |
| Heating Oil | TJ | 958 | 4591 | - | - | 254 | - | 2326 | 31277 | 48772 | 3804 | - | - | - | 8514 | - | - | - | - | - | - | 1009 | - | - | 680 | 1963 | 2500 |
| Natural gas | TJ | 2064 | 6092 | - | - | 1539 | - | 0 | 33005 | 46418 | - | - | - | - | 32346 | - | - | - | - | - | - | - | - | - | 549 | 502 | 73900 |
| LPG and Manuf. gas | TJ | 4 | - | - | - | 11 | - | na | na | - | 100 | - | - | - | 212 | - | - | - | - | - | - | 121 | - | - | 60 | na | - |
| Solid fuels | TJ | na | 38 | - | - | - | - | - | - | 3840 | 1382 | - | - | - | na | - | - | - | - | - | - | - | - | - | 5 | na | 100 |
| Electricity | TJ | 1219 | 160 | - | - | 92 | - | 317 | 8132 | 4809 | 0 | - | - | - | 1138 | - | - | - | - | - | - | 295 | - | - | 127 | 306 | 2600 |
| District heating | TJ | 6072 | - | - | - | 4308 | - | 5465 | - | - | - | - | - | - | 23068 | - | - | - | - | - | - | - | - | - | - | 1137 | - |
| Other | TJ | 255 | 116 | - | - | - | - | 143 | 8927 | 16819 | - | - | - | - | 72 | - | - | - | - | - | - | - | - | - | 9 | 665 | - |
| TOTAL | TJ | 10572 | 10997 | - | - | 6204 | - | 8251 | 81341 | 120658 | 5286 | - | - | - | 65350 | - | - | - | - | - | - | 1425 | - | - | 1430 | 14806 | - |
| 3. Education (NACE 80) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Consumption per m ² (MJ/m ²) | | - | - | - | - | 410 | - | 678 | 490 | 655 | na | - | - | - | - | - | - | - | - | - | - | - | - | - | 251 | 523 | - |
| Heating Oil | TJ | 3919 | 7855 | - | - | 348 | - | 3045 | 27090 | 36716 | na | - | - | - | 3462 | - | - | - | - | - | - | 96 | - | - | 616 | 3785 | 40900 |
| Natural gas | TJ | 5560 | 7611 | - | - | 1606 | - | 56 | 33299 | 34956 | na | - | - | - | 10861 | - | - | - | - | - | - | - | - | - | 409 | 264 | 44000 |
| LPG and Manuf. gas | TJ | 43 | 33 | - | - | 25 | - | na | na | - | na | - | - | - | 5 | - | - | - | - | - | - | 293 | - | - | 22 | na | - |
| Solid fuels | TJ | na | 36 | - | - | - | - | na | na | 2897 | na | - | - | - | na | - | - | - | - | - | - | - | - | - | 1 | na | 13900 |
| Electricity | TJ | 575 | 93 | - | - | 131 | - | 198 | 5216 | 821 | na | - | - | - | 155 | - | - | - | - | - | - | 229 | - | - | 38 | 814 | 5900 |
| District heating | TJ | 3984 | - | - | - | 5647 | - | 5116 | - | - | - | - | - | - | 10 | - | - | - | - | - | - | - | - | - | - | 8362 | - |
| Other | TJ | 288 | 94 | - | - | - | - | 407 | 10466 | 12665 | na | - | - | - | 0 | - | - | - | - | - | - | - | - | - | 1 | 565 | - |
| TOTAL | TJ | 14369 | 15722 | - | - | 7757 | - | 8822 | 76071 | 88055 | na | - | - | - | 14493 | - | - | - | - | - | - | 618 | - | - | 1087 | 1379 | - |
| 4. Other community, social and personal service activities (NACE 90-93) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Consumption per m ² (MJ/m ²) | | - | - | - | - | 395 | - | 851 | 979 | 842 | na | - | - | - | - | - | - | - | - | - | - | - | - | - | 264 | 502 | - |
| Heating Oil | TJ | 3604 | 7451 | - | - | 269 | - | 719 | 10174 | 17512 | 376 | - | - | - | 3906 | - | - | - | - | - | - | 281 | - | - | 137 | 1615 | 31800 |
| Natural gas | TJ | 4163 | 14048 | - | - | 1097 | - | 3 | 19840 | 16654 | 66 | - | - | - | 29214 | - | - | - | - | - | - | - | - | - | 323 | 112 | 57600 |
| LPG and Manuf. gas | TJ | 133 | 53 | - | - | 15 | - | na | na | - | - | - | - | - | 219 | - | - | - | - | - | - | 1415 | - | - | 18 | na | - |
| Solid fuels | TJ | na | 6 | - | - | - | - | na | na | 1392 | 800 | - | - | - | na | - | - | - | - | - | - | - | - | - | 0 | na | 20500 |
| Electricity | TJ | 1156 | 158 | - | - | 148 | - | 281 | 8042 | 6059 | 0 | - | - | - | 1732 | - | - | - | - | - | - | 716 | - | - | 140 | 749 | - |
| District heating | TJ | 4326 | - | - | - | 3456 | - | 2093 | - | - | - | - | - | - | 7537 | - | - | - | - | - | - | - | - | - | - | 2451 | - |
| Other | TJ | 2998 | 112 | - | - | - | - | 489 | 2222 | 6034 | 4 | - | - | - | 8096 | - | - | - | - | - | - | - | - | - | 0 | 142 | - |
| TOTAL | TJ | 16380 | 21828 | - | - | 4985 | - | 3585 | 40278 | 47651 | 1246 | - | - | - | 50704 | - | - | - | - | - | - | 2412 | - | - | 618 | 5069 | - |

Table 3.b. c'td EU Services sector: Energy consumption for space heating and hot water 1995-1999 (source: VHK compilation of Eurostat 2002)

| Parameter | unit | EU-25 | AT | BE | CY | CZ | DK | EE | FI | FR | DE | EL | HU | IE | IT | LV | LT | LU | MT | NL | PL | PT | SK | SI | ES | SE | UK* | |
|---------------------------------------------------------------|---------------------|-------|--------|--------|----|-------|-----|-------|--------|---------|-------|-------|----|--------|----|----|----|----|-------|----|-------|----|----|----|-------|-------|--------|---|
| 5.- Offices and Administration (NACE 60-67, 70-75, 99) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Consumption per m ² (MJ/m ²) | | | | | | | na | | 613 | 698 | 911 | na | | | | | | | 370 | | | | | | 193 | 486 | | |
| Heating Oil | | 2953 | 16047 | - | - | 1099 | - | 4102 | 35799 | 83289 | 1598 | - | - | 11561 | - | - | - | - | 296 | - | 1227 | - | - | - | 1373 | 4555 | 9500 | |
| Natural gas | | 3268 | 16105 | - | - | 1741 | - | 20 | 48664 | 76700 | 0 | - | - | 71509 | - | - | - | - | 12375 | - | - | - | - | - | 1092 | 1439 | 91800 | |
| LPG and Manuf. gas | | 771 | 8 | - | - | 38 | - | na | na | 2568 | 46 | - | - | 123 | - | - | - | - | - | - | 1386 | - | - | - | 143 | na | - | |
| Solid fuels | | na | 24 | - | - | - | - | na | na | 6567 | 3673 | - | - | na | - | - | - | - | - | - | - | - | - | - | 27 | na | 3900 | |
| Electricity | | 2861 | 643 | - | - | 304 | - | 1742 | 23594 | 12042 | 0 | - | - | 2088 | - | - | - | - | 10409 | - | 1234 | - | - | - | 2391 | 1735 | 15400 | |
| District heating | | 5062 | - | - | - | 6798 | - | 11305 | - | - | - | - | - | 14041 | - | - | - | - | 990 | - | - | - | - | - | - | 14765 | - | |
| Other | | 379 | 60 | - | - | - | - | 208 | 15475 | 28721 | 6 | - | - | 376 | - | - | - | - | 80 | - | - | - | - | - | 5 | 312 | - | |
| TOTAL | | 15294 | 32887 | - | - | 9980 | - | 17377 | 123532 | 209887 | 5323 | - | - | 99698 | - | - | - | - | 24150 | - | 3847 | - | - | - | 5031 | 22806 | - | |
| 6. Commerce (NACE 50-52). | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Consumption per m ² (MJ/m ²) | | | | | | | 306 | | 657 | 446 | 666 | na | | | | | | | | | | | | | 226 | 494 | - | |
| Heating Oil | | 2541 | 6123 | - | - | 3140 | - | 4229 | 26127 | 72079 | 3097 | - | - | 1586 | - | - | - | - | - | - | 0 | - | - | - | 148 | 1139 | 10500 | |
| Natural gas | | 1415 | 6511 | - | - | 1137 | - | 499 | 28935 | 68004 | 0 | - | - | 31308 | - | - | - | - | - | - | - | - | - | - | 249 | 156 | 47000 | |
| LPG and Manuf. gas | | 212 | 101 | - | - | 95 | - | na | na | 605 | 421 | - | - | 51 | - | - | - | - | - | - | 163 | - | - | - | 4 | na | - | |
| Solid fuels | | na | - | - | - | - | - | na | na | 5692 | 10010 | - | - | na | - | - | - | - | - | - | - | - | - | - | 0 | na | 17200 | |
| Electricity | | 732 | 802 | - | - | 499 | - | 774 | 18464 | 14522 | 1 | - | - | 2653 | - | - | - | - | - | - | 1214 | - | - | - | 1419 | 1105 | - | |
| District heating | | 625 | - | - | - | 7018 | - | 783 | - | - | - | - | - | 242 | - | - | - | - | - | - | - | - | - | - | - | 3724 | - | |
| Other | | 869 | 51 | - | - | - | - | 27 | 4760 | 24858 | 50 | - | - | 0 | - | - | - | - | - | - | - | - | - | - | 0 | 132 | - | |
| TOTAL | | 6394 | 13588 | - | - | 11889 | - | 13359 | 78286 | 185760 | 13579 | - | - | 35840 | - | - | - | - | - | - | 1377 | - | - | - | 1820 | 6256 | - | |
| Space heating & SHW TOTALS BY FUEL | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Consumption per m ² (MJ/m ²) | | 80 | | | | | | | 697 | 616 | 839 | na | | | | | | | | | | | | | | 255 | 516 | - |
| Heating Oil | | 17531 | 4428 | - | - | 5429 | - | 15394 | 145791 | 286370 | 11388 | - | - | 45469 | - | - | - | - | - | - | 3852 | - | - | - | 4310 | 14258 | 118400 | |
| Natural gas | | 17356 | 57075 | - | - | 7572 | - | 644 | 183363 | 267411 | 0 | - | - | 235278 | - | - | - | - | - | - | - | - | - | - | 3261 | 2536 | 359500 | |
| LPG and Manuf. gas | | 1500 | 308 | - | - | 293 | - | na | na | 5138 | 1127 | - | - | 16624 | - | - | - | - | - | - | 7386 | - | - | - | 415 | na | - | |
| Solid fuels | | na | 104 | - | - | - | - | na | na | 22588 | 21964 | - | - | na | - | - | - | - | - | - | - | - | - | - | 35 | na | 18500 | |
| Electricity | | 8614 | 2 | - | - | 1407 | - | 3798 | 71562 | 46572 | 1 | - | - | 10524 | - | - | - | - | - | - | 4130 | - | - | - | 4583 | 5249 | 64800 | |
| District heating | | 20545 | - | - | - | 28281 | - | 33706 | - | - | - | - | - | 59423 | - | - | - | - | - | - | - | - | - | - | - | 4218 | - | |
| Other | | 5968 | 433 | - | - | - | - | 1361 | 46951 | 98749 | 170 | - | - | 9007 | - | - | - | - | - | - | - | - | - | - | 15 | 2013 | - | |
| TOTAL | | 71515 | 1042 | - | - | 42982 | - | 54902 | 447667 | 726828 | 34648 | - | - | 376325 | - | - | - | - | - | - | 15367 | - | - | - | 12619 | 66235 | 561200 | |
| Service Sector TOTALS BY FUEL | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Heating Oil | | | 44280 | - | - | 19288 | - | 15394 | 158656 | 536000 | na | - | - | 45469 | - | - | - | - | - | - | - | - | - | - | 5352 | - | - | |
| Natural gas | | | 57075 | - | - | 9888 | - | 644 | 211457 | 420000 | na | - | - | 235278 | - | - | - | - | - | - | - | - | - | - | 5515 | - | - | |
| LPG and Manuf. gas | | | 308 | - | - | 293 | - | na | na | 26000 | na | - | - | 16624 | - | - | - | - | - | - | - | - | - | - | 1424 | - | - | |
| Solid fuels | | | 104 | - | - | - | - | na | na | 436000 | na | - | - | 0 | - | - | - | - | - | - | - | - | - | - | 135 | - | - | |
| Electricity | | | 47844 | - | - | 34934 | - | 44176 | 262562 | 115 | na | - | - | 204576 | - | - | - | - | - | - | - | - | - | - | 44060 | - | - | |
| District heating | | | - | - | - | 28380 | - | 33706 | - | - | - | - | - | 59423 | - | - | - | - | - | - | - | - | - | - | - | - | - | |
| Other /DH | | | 433 | - | - | - | - | 1361 | 54587 | 3000 | na | - | - | 14680 | - | - | - | - | - | - | - | - | - | - | 25 | - | - | |
| TOTAL | | | 144278 | 150044 | - | 92783 | - | 95281 | 687262 | 1536000 | na | - | - | 576050 | - | - | - | - | - | - | - | - | - | - | 56511 | - | - | |
| YEAR | | | 1998 | 1996 | - | 1997 | - | 1998 | 1996 | 1997 | 1998 | - | - | 1999 | - | - | - | - | - | - | - | - | - | - | 1998 | 1997 | 1995 | |
| floor area referred to | mln. M ² | | | | | | | 116 | | 726 | 866 | 24-29 | | | | | | | | 65 | 81 | | | 49 | | | | |

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* = UK No breakdown by branch is available for space heating and hot water but for all uses. The figures shown by branch correspond to all uses and their addition is not equal to the figures shown under TOTAL
source: *Energy consumption in the services sector, Survey of EU Member States*, European Communities 2002.

Table . Floor area per type, age and climate (Ecofys 2006)

| Climate | Building age | Total (mio m ²) | one- family (mio m ²) | apartment small (mio m ²) | apartment large (mio m ²) | small office (mio m ²) | large office (mio m ²) |
|----------|---------------|--------------------------------|-----------------------------------------|---------------------------------------------|---------------------------------------------|------------------------------------------|------------------------------------------|
| | year | | | | | | |
| cold | <1975 | 534 | 220 | 109 | 59 | 55 | 92 |
| | 1975- 1990 | 154 | 63 | 31 | 17 | 16 | 27 |
| | >1990 | 120 | 31 | 26 | 14 | 18 | 30 |
| moderate | <1975 | 9145 | 4607 | 1242 | 669 | 780 | 1848 |
| | 1975- 1990 | 2551 | 1290 | 348 | 187 | 216 | 511 |
| | >1990 | 1708 | 670 | 181 | 97 | 226 | 535 |
| warm | <1975 | 3116 | 1197 | 769 | 414 | 319 | 416 |
| | 1975- 1990 | 1945 | 748 | 480 | 259 | 199 | 259 |
| | >1990 | 1175 | 399 | 256 | 138 | 166 | 216 |

Table . ECCP Residential sector Baselines 1990-2010 (all values in Mt CO₂ eq.)

| RESIDENTIAL SECTOR | | Fuel-Related CO₂ emissions (in Mt CO₂) | |
|-------------------------------------|-----------------------|---------------------------------------------------------------------|--|
| Sector/function group | Reference 1990 | Baseline 2010 | |
| Total | 762 | 797 | |
| of which | | | |
| Spaceheating/cooling, of which | 481 | 466 | |
| Fossil, of which | 371 | 350 | |
| Transmission losses | 190 | 186 | |
| -windows | 75 | 70 | |
| -walls | 55 | 55 | |
| -floors | 30 | 30 | |
| -roofs | 30 | 30 | |
| Ventilation losses | 70 | 73 | |
| Heating system losses | 111 | 91 | |
| Electric, of which | 90 | 88 | |
| Heating (incl. heatpump) | 73 | 68 | |
| Cooling (airconditioners) | 2 | 3 | |
| CH pump | 15 | 17 | |
| District heating | 20 | 28 | |
| Hot water, of which | 103 | 115 | |
| Fossil | 67 | 84 | |
| Electric | 36 | 31 | |
| Whitegoods & Cooking, of which | 109 | 84 | |
| Fossil (mainly hobs) | 9 | 9 | |
| Electric, of which | 100 | 75 | |
| Refrigeration/freezers | 62 | 43 | |
| Washing machines | 20 | 11 | |
| Dishwashers | 7 | 8 | |
| Laundry driers | 4 | 6 | |
| Electric ovens | 7 | 7 | |
| Lighting (electr.) | 40 | 50 | |
| Electronics, of which | 16 | 64 | |
| Consumer el. (TV, audio, IRD, etc.) | 15 | 35 | |
| Stand-by | 7 | 12 | |
| On' | 7 | 23 | |
| IT/ office equipment | 1 | 29 | |
| Other(electric) | 18 | 18 | |
| Autogeneration | 0 | 0 | |
| Total (check) | 767 | 797 | |
| of which (by energy source) | | | |
| Fossil | 447 | 443 | |
| Electricity | 300 | 326 | |
| Heat | 20 | 28 | |

Source: Composed by VHK 2002 for the European Commission on basis of European Climate Change Programme(ECCP) working group reports & docs JSWG and WG3 ('provisional analysis'), European Commission, 2001.

Note: Conversion Electricity 1990: 1 TWh el. = 0.5 Mt CO₂; 2010 1 TWh el.= 0.45 Mt CO₂

Industrial & Tertiary Sector Buildings

For industrial buildings no attempts to make an EU-wide analysis of the heating requirements were found. Also PRIMES and Eurostat figures on the industry are at such an aggregated level that it is impossible to make a split-up that would lead to the identification of space heating requirements. This means that we have to rely on the stakeholder approach in the ECCP and national statistics and surveys.

The relevant extract of the ECCP is given in the Table. It identifies 76 Mt CO₂ for space heating and cooling in 1990 and projects 72 Mt CO₂ in 2010, but the share of district heating is not known. Without the cooling and the CH pump these figures are 65 Mt CO₂ (1990) and 57 Mt CO₂ (2010). Compared to the tertiary sector in Table 4-3 this means that the industrial space heating requirement in the industrial sector is around 23% of that in the tertiary sector.

By way of illustration, some German national statistics are given in Tables 2 and 3. These relate to the 2004 building permits by type, size (in cubic metres), fuel and heating type. For a better comparison we included all sectors, i.e. also residential and tertiary sectors. The German statistics show 14087 permits for non-residential buildings ('Nichtwohngebäude') in 2004 with a total building volume of 122,6 million m³. Of this, there are some 2890 factories ('Fabrik- und Werkstattgebäude') with a total building volume of 28,2 million m³. This is exactly 23%, as mentioned in the ECCP 2003.

Furthermore, Table 4-5 also shows that the use of fuels is not very different. For all non-residential buildings the building volume share of natural gas is 68,8% whereas for industrial buildings this is 67%. Non-residential buildings as a whole use relatively more district heating (18% vs. 13%) and less

Also in terms of the type of heating systems the differences are smaller than one might expect. According to Table 3 around 75% of all heated non-residential buildings has central heating, whereas in industrial buildings this is 78%. The share of direct air heaters, which would fall in the category single room heaters ('Einzelraumheizung') is still relatively modest at 8% of the industrial building total.

So, although these statistics relate only to 18% of the EU and to building permits and not the installed stock, they show that at least in terms of heated building volume, fuel and heating system the ECCP figure of 23% is not unlikely.

The tables also give some other data that at least give an order of magnitude of certain building characteristics. Regarding the average building size, the average new German non-residential building has a building volume of 8750 m³, which –at an assumed gross storey height of 3,5 m— results in around 2.500 m². Anecdotal data shows that the distribution is not equal: almost half of the total floor area is in a relatively small number of large buildings (> 10.000 m²), followed by the size class <500 m² with around 80% of buildings which represent 30-40% of the floor area. The middle classes, e.g. the volume between 1000 and 10.000 m² is relatively small, but this could be exactly the area where many smaller industrial buildings (office+factory) are to be found.

The new German average industrial building has a volume of 9744 m³, which –given a higher room height—may well translate also into 2500 m² floor area.

The question remains, whether the heat load between industrial and commercial buildings is comparable. On the one hand, one can expect that the average indoor temperature in factories is lower than in an office (e.g. 18 vs. 21°C). On the other hand, the working hours may be longer in 2/3 and full-shift factories.

For that reason we present the findings of the Statistics Norway report and more specifically the measurements that were done by ENOVAS of over 1000 buildings of various types. Norway is not a member of the EU-25 but from the analytical point of view the data are very interesting. In Norway 88% of the space heating in almost all sectors is electric, i.e. the energy consumption data are hardly

'polluted' by generation losses of boilers or distribution losses in the buildings. In other words the total consumption figures give a good impression of the actual heat load in Norway.³¹ The Norwegian climate in terms of degree-days (5476 in 2003, 5312 in 2004) is similar to that in Finland.³² The average daily temperature in Oslo is 5,9°C (compare: Helsinki 5,6°C).

For climate reasons, also confirmed by the figures for the residential sector in the previous chapter, the heat load of Norwegian buildings should then be around 70-80% above the EU-average. For the various NACE branches the split-up are given below in Table 4.

But more important than the absolute figures of the split-up, which clearly show how Norwegian houses are heated also through waste heat from lighting and ventilation, is the fact that the ENOVAS data show that relatively the figures of the heated manufacturing buildings are on average not very different from the tertiary sector. Also, as we have assumed in par. 4.1, it confirms that on average the energy consumption per square meter is higher in non-residential buildings than in residential buildings.

³¹ In any other country there should be a 10-20% correction for control losses and all losses of non-electric heating, but it must be considered that the internal heat gain from lighting in Norway is much higher than in other countries because of the abundant availability of (hydro-based) electric energy. In fact, a few years ago some utilities promoted to 'heat your house with light'. For that reason we think that no correction is needed.

³² Eurostat, Temperature correction of final energy consumption, meeting of the working group 'Energy Statistics Committee', Luxembourg, 13-14 June 2005.

Table . Industrial Sector Baselines 1990- 2010 (ECCP 2003)

| INDUSTRIAL SECTOR | | Fuel-Related CO ₂ emissions (in Mt CO ₂) | |
|--------------------------------|----------------|-----------------------------------------------------------------|--|
| Sector/function group | Reference 1990 | Baseline 2010 | |
| Total | 1031 | 959 | |
| of which | | | |
| Spaceheating/cooling, of which | <u>76</u> | <u>72</u> | |
| Fossil,of which | <u>57</u> | <u>53</u> | |
| Transmission losses | <u>29</u> | <u>28</u> | |
| -windows | 11 | 10 | |
| -walls | 8 | 8 | |
| -floors | 5 | 5 | |
| -roofs | 5 | 5 | |
| Ventilation losses | 11 | 11 | |
| Heating system losses | 17 | 14 | |
| Electric, of which | <u>19</u> | <u>19</u> | |
| Heating (incl. heatpump) | 8 | 7 | |
| Cooling (airconditioners) | 8 | 12 | |
| CH pump | 3 | 3 | |
| District heating | na | na | |

Source: Composed by VHK 2002 on basis of European Climate Change Programme(ECCP) working group reports & docs JSWG and WG3 ('provisional analysis'), European Commission, 2001.

* = rough estimates based on PRIMES figures for 2010 following The Shared Analysis project "Economic Foundations for Energy Policy", European Commission, Dec. 1999. PRIMES "full flexibility scenario incl. ACEA agreement" with a price of 20 EUR/t CO₂ abated. Accuracy plus or minus 10-15%.

Note: Conversion Electricity 1990: 1 TWh el. = 0.5 Mt CO₂; 2010 1 TWh el.= 0.45 Mt CO₂

Table . Tertiary Sector Baselines 1990-2010

| TERTIARY SECTOR Sector/function group | Fuel-Related CO ₂ emissions (in Mt CO ₂) | |
|------------------------------------------|-----------------------------------------------------------------|---------------|
| | Reference 1990 | Baseline 2010 |
| Total | 457 | 523 |
| <i>of which</i> | | |
| Spaceheating/cooling, <i>of which</i> | 305 | 308 |
| Fossil, <i>of which</i> | 227 | 214 |
| Transmission losses | 116 | 113 |
| -windows | 46 | 43 |
| -walls | 34 | 34 |
| -floors | 18 | 18 |
| -roofs | 18 | 18 |
| Ventilation losses | 43 | 45 |
| Heating system losses | 68 | 56 |
| Electric, <i>of which</i> | 78 | 94 |
| Heating (incl. heatpump) | 33 | 31 |
| Cooling (airconditioners) | 32 | 48 |
| CH pump | 13 | 15 |
| District heating | ? | ? |
| Hot water, <i>of which</i> | 35 | 39 |
| Fossil | 24 | 30 |
| Electric | 11 | 9 |
| Whitegoods & Cooking, <i>of which</i> | 26 | 37 |
| Fossil (mainly hobs) | | |
| Electric, <i>of which</i> | 26 | 37 |
| Refrigeration/freezers | 14 | 20 |
| Washing machines | | |
| Dishwashers | | |
| Laundry driers | | |
| Electric ovens | 12 | 17 |
| Lighting (incl. Street lighting) | 65 | 89 |
| Electronics, <i>of which</i> | 14 | 34 |
| Consumer el. (TV, audio, IRD, etc.) | | |
| Stand-by | | |
| On' | | |
| IT/office equipment | 14 | 34 |
| Other (conveyors & misc.) | 12 | 16 |
| Ind. process heat | | |
| Autogeneration | neg | neg |
| Total (check) | 457 | 523 |
| <i>of which (by energy source)</i> | | |
| Fossil | 251 | 244 |
| Electricity | 206 | 279 |
| Heat | ? | ? |

Source: Composed by VHK 2002 on basis of European Climate Change Programme (ECCP) working group reports & docs JSWG and WG3 ('provisional analysis'), European Commission, 2001.

Note: Conversion Electricity 1990: 1 TWh el. = 0.5 Mt CO₂; 2010 1 TWh el. = 0.45 Mt CO₂

Table . Deutschland, Genehmigte Bauvorhaben im Hochbau 2004, 2.2 Errichtung neuer Gebäude, 2.2.6 Genehmigungen im Wohn- und Nichtwohnbau nach Gebäudearten und Art der vorwiegend verwendeten Heizenergie *)

| Gebäudeart | Insgesamt | Vorwiegend verwendete Heizenergie | | | | | | | |
|-------------------------------------------|-----------|-----------------------------------|--------|---------|-------|----------------|-----------------|-------------------|----------|
| | | Koks/ Kohle | Öl | Gas | Strom | Fern- wärme | Wärme- pumpe | Solar- energie | Sonstige |
| Wohngebäude zusammen | 160.288 | 331 | 19.058 | 120.788 | 2.305 | 6.868 | 6.038 | 448 | 4.452 |
| darin: Wohnungen | 236.352 | 497 | 25.022 | 177.080 | 2.837 | 17.328 | 7.383 | 542 | 5.663 |
| davon: | | | | | | | | | |
| Wohngebäude mit 1 Wohnung | 134.895 | 269 | 15.290 | 102.585 | 1.952 | 5.609 | 5.181 | 385 | 3.624 |
| Wohngebäude mit 2 Wohnungen | 16.076 | 46 | 2.971 | 10.912 | 289 | 395 | 722 | 52 | 689 |
| Wohngebäude mit 3 o.m. Wohnungen | 9.146 | 15 | 785 | 7.164 | 61 | 838 | 134 | 11 | 138 |
| darin: Wohnungen | 68.504 | 136 | 3.660 | 52.156 | 307 | 10.779 | 758 | 53 | 655 |
| Wohnheime | 171 | 1 | 12 | 127 | 3 | 26 | 1 | - | 1 |
| darin: Wohnungen | 801 | - | 130 | 515 | - | 150 | - | - | 6 |
| darunter: | | | | | | | | | |
| Wohngeb. mit Eigentumswohnungen | 6.120 | 13 | 348 | 4.920 | 34 | 624 | 78 | 6 | 97 |
| darin: Wohnungen | 39.891 | 117 | 1.375 | 30.938 | 160 | 6.561 | 404 | 21 | 315 |
| Nichtwohngebäude zusammen | 14.087 | 73 | 1.792 | 9.425 | 800 | 1.183 | 193 | 27 | 594 |
| darin: Rauminhalt (1 000 m ³) | 122.624 | 357 | 10.577 | 84.463 | 1.820 | 21.901 | 923 | 88 | 2.496 |
| davon: | | | | | | | | | |
| Anstaltsgebäude | 617 | 3 | 45 | 381 | 46 | 140 | 1 | - | 1 |
| darin: Rauminhalt (1 000 m ³) | 6.779 | 15 | 644 | 4.111 | 24 | 1.973 | 10 | - | 3 |
| Büro- und Verwaltungsgebäude | 1.956 | 2 | 199 | 1.315 | 113 | 248 | 35 | 6 | 38 |
| darin: Rauminhalt (1 000 m ³) | 15.693 | 5 | 674 | 9.773 | 75 | 4.881 | 193 | 13 | 80 |
| Landwirtschaftl. Betriebsgebäude | 776 | 13 | 140 | 388 | 66 | 20 | 21 | 3 | 125 |
| darin: Rauminhalt (1 000 m ³) | 4.376 | 29 | 765 | 2.824 | 257 | 62 | 122 | 9 | 308 |
| Nichtlandwirt. Betriebsgebäude | 8.342 | 42 | 1.155 | 5.806 | 424 | 456 | 89 | 10 | 360 |
| darin: Rauminhalt (1 000 m ³) | 85.000 | 302 | 7.693 | 61.584 | 1.303 | 11.779 | 396 | 39 | 1.905 |
| darunter: | | | | | | | | | |
| Fabrik- und Werkstattgebäude | 2.890 | 10 | 480 | 1.843 | 169 | 157 | 36 | 3 | 192 |
| darin: Rauminhalt (1 000 m ³) | 28.163 | 183 | 3.631 | 18.944 | 516 | 3.289 | 173 | 10 | 1.419 |
| Handels- und Lagergebäude | 4.014 | 16 | 455 | 3.062 | 153 | 202 | 35 | 5 | 86 |
| darin: Rauminhalt (1 000 m ³) | 48.408 | 111 | 3.603 | 36.891 | 616 | 6.609 | 181 | 20 | 378 |
| Hotels und Gaststätten | 581 | 5 | 93 | 381 | 24 | 48 | 6 | - | 24 |
| darin: Rauminhalt (1 000 m ³) | 2.524 | 2 | 179 | 1.503 | 14 | 762 | 27 | - | 37 |
| Sonstige Nichtwohngebäude | 2.396 | 13 | 253 | 1.535 | 151 | 319 | 47 | 8 | 70 |
| darin: Rauminhalt (1 000 m ³) | 10.776 | 6 | 801 | 6.171 | 162 | 3.207 | 201 | 27 | 200 |
| darunter: | | | | | | | | | |
| Ausgewählte Infrastrukturgebäude | 3.327 | 12 | 330 | 2.117 | 253 | 465 | 48 | 8 | 94 |
| darin: Rauminhalt (1 000 m ³) | 21.858 | 20 | 1.584 | 13.261 | 252 | 5.961 | 219 | 27 | 534 |

*) Einschl. Fertigteilbau.

Source: Statistisches Bundesamt, Fachserie 5, R. 1, 2004

Table 3. Deutschland, Genehmigte Bauvorhaben im Hochbau 2004, 2.2 Errichtung neuer Gebäude, 2.2.5 Genehmigungen im Wohn- und Nichtwohnbau nach Gebäudearten und Art der Beheizung *)

| Gebäudeart | Ins- gesamt | Darunter mit | | | | | ohne Heizung |
|-------------------------------------------|----------------|------------------|-------------------|---------------------|--------------------|-----------------------------|-----------------|
| | | Fern- heizung | Block- heizung | Zentral- heizung | Etagen- heizung | Einzel- raum- heizung | |
| Wohngebäude zusammen | 160.311 | 6.868 | 770 | 150.471 | 1.022 | 1.157 | 23 |
| darin: Wohnungen | 236.378 | 17.328 | 1.847 | 213.420 | 2.237 | 1.520 | 26 |
| davon: | | | | | | | |
| Wohngebäude mit 1 Wohnung | 134.915 | 5.609 | 628 | 127.170 | 540 | 948 | 20 |
| Wohngebäude mit 2 Wohnungen | 16.079 | 395 | 24 | 15.273 | 221 | 163 | 3 |
| Wohngeb. mit 3 o. m. Wohnungen | 9.146 | 838 | 116 | 7.888 | 260 | 44 | - |
| darin: Wohnungen | 68.504 | 10.779 | 1.162 | 55.062 | 1.255 | 246 | - |
| Wohnheime | 171 | 26 | 2 | 140 | 1 | 2 | - |
| darin: Wohnungen | 801 | 150 | 9 | 642 | - | - | - |
| darunter: | | | | | | | |
| Wohngeb. mit Eigentumswohnungen | 6.120 | 624 | 109 | 5.237 | 134 | 16 | - |
| darin: Wohnungen | 39.891 | 6.561 | 559 | 32.037 | 620 | 114 | - |
| Nichtwohngebäude zusammen | 28.138 | 1.183 | 233 | 11.261 | 139 | 1.271 | 14.051 |
| darin: Rauminhalt (1 000 m ³) | 165.431 | 21.901 | 2.648 | 92.423 | 665 | 4.986 | 42.808 |
| davon: | | | | | | | |
| Anstaltsgebäude | 617 | 140 | 10 | 418 | 2 | 47 | - |
| darin: Rauminhalt (1 000 m ³) | 6.779 | 1.973 | 160 | 4.607 | 17 | 22 | - |
| Büro- und Verwaltungsgebäude | 1.956 | 248 | 16 | 1.555 | 31 | 106 | - |
| darin: Rauminhalt (1 000 m ³) | 15.693 | 4.881 | 155 | 10.420 | 146 | 91 | - |
| Landwirtschaftl. Betriebsgebäude | 7.570 | 20 | 41 | 485 | 4 | 226 | 6.794 |
| darin: Rauminhalt (1 000 m ³) | 24.443 | 62 | 511 | 2.746 | 5 | 1.052 | 20.067 |
| Nichtlandwirtsch. Betriebsgebäude | 15.190 | 456 | 121 | 6.968 | 75 | 722 | 6.848 |
| darin: Rauminhalt (1 000 m ³) | 106.828 | 11.779 | 1.505 | 67.621 | 456 | 3.640 | 21.828 |
| darunter: | | | | | | | |
| Fabrik- und Werkstattgebäude | 3.849 | 157 | 81 | 2.332 | 20 | 300 | 959 |
| darin: Rauminhalt (1 000 m ³) | 31.682 | 3.289 | 853 | 22.137 | 96 | 1.788 | 3.518 |
| Handels- und Lagergebäude | 7.223 | 202 | 23 | 3.495 | 41 | 253 | 3.209 |
| darin: Rauminhalt (1 000 m ³) | 62.509 | 6.609 | 443 | 39.459 | 325 | 1.572 | 14.101 |
| Hotels und Gaststätten | 581 | 48 | 7 | 477 | 6 | 43 | - |
| darin: Rauminhalt (1 000 m ³) | 2.524 | 762 | 63 | 1.670 | 10 | 19 | - |
| Sonstige Nichtwohngebäude | 2.805 | 319 | 45 | 1.835 | 27 | 170 | 409 |
| darin: Rauminhalt (1 000 m ³) | 11.687 | 3.207 | 317 | 7.029 | 41 | 181 | 912 |
| darunter: | | | | | | | |
| Ausgewählte Infrastrukturgebäude | 3.976 | 465 | 76 | 2.479 | 29 | 278 | 649 |
| darin: Rauminhalt (1 000 m ³) | 23.559 | 5.961 | 521 | 14.955 | 70 | 350 | 1.701 |

*) Einschl. Fertigteilbau.

Statistisches Bundesamt, Fachserie 5, R. 1, 2004

oil (8 vs. 13%), but the differences are not dramatic.

Table . Summary tables Norway energy consumption in the services sector 2000 (source: Statistics Norway 2005)

Consumption for space heating and hot water. 2000. Branches 1-6. TJ

| | average | Heating oil | Electricity | District heating | Paraffin | Fluid propane and butane | Other | Total |
|----------------------------|--------------------|-------------|-------------|------------------|----------|--------------------------|-------|--------|
| | kWh/m ² | TJ | TJ | TJ | TJ | TJ | TJ | TJ |
| Total (1-6) Branches | 98.4 | 11 348 | 37 652 | 3 587 | 42 | 12 | 189 | 52 830 |
| 1 Hotels & Restaurants | 201.6 | 118 | 2 483 | 105 | 0 | 6 | 3 | 2 715 |
| 2 Health & Social work | 79.2 | 1 502 | 3 719 | 27 | 19 | - | 26 | 5 293 |
| 3 Education | 99.2 | 847 | 4 393 | 645 | 5 | - | - | 5 890 |
| 4 Other community services | 69.9 | 1 219 | 6 868 | 595 | 8 | - | 141 | 8 831 |
| 5 Offices & Administration | 69.9 | 6 524 | 11 107 | 1 819 | 6 | - | 19 | 19 476 |
| 6 Commerce | 157.2 | 1 138 | 9 083 | 396 | 3 | 6 | 0 | 10 626 |

Consumption for specific uses of electricity. 2000. Branches 1-6. GWh

| | Lighting | | Heating/hot water | Cooling and freezing | Ventilation and air-condition | Electrical appliances | Other | Total |
|----------------------------|--------------------|-------|-------------------|----------------------|-------------------------------|-----------------------|-------|--------|
| | kWh/m ² | GWh | GWh | GWh | GWh | GWh | GWh | GWh |
| Total (1-6) Branches | 62,8 | 6 208 | 10 471 | 2 242 | 2 450 | 1 879 | 1 110 | 24 359 |
| 1 Hotels & Restaurants | 69,3 | 291 | 690 | 213 | 254 | 124 | 146 | 1 718 |
| 2 Health & Social work | 64,6 | 615 | 1 035 | 176 | 226 | 188 | 108 | 2 348 |
| 3 Education | 51,1 | 727 | 1 222 | 208 | 266 | 223 | 128 | 2 774 |
| 4 Other community services | 55,8 | 1 136 | 1 911 | 326 | 417 | 348 | 200 | 4 337 |
| 5 Offices & Administration | 55,8 | 1 837 | 3 090 | 527 | 674 | 563 | 323 | 7 013 |
| 6 Commerce | 79,1 | 1 602 | 2 524 | 792 | 613 | 433 | 205 | 6 169 |

Table . Measurements of energy consumption in Norwegian buildings in kWh/m² heated area, year 2000 (source: ENOVAS in Statistics Norway 2005)

| Type of building | # | energy corrected (kWh/m ²) | energy (kWh/m ²) | energy-split | | | | |
|------------------------------------------|-----------|-------------------------------------------|---------------------------------|-----------------|-------------|-------------|------------|------------|
| | | | | Electricity (%) | Oil (%) | Heat (%) | Gas (%) | Other (%) |
| Total | 1039 | 247.8 | 230.2 | 84.9 | 10.6 | 4.1 | 0.1 | 0.2 |
| 1 Houses | 13 | 196.5 | 181.6 | 80.2 | 19.8 | 0.0 | 0.0 | 0.0 |
| 13 Row house | 3 | 183.7 | 171.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 131 Row house with 3 and 4 flats | 1 | 151.0 | 141.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 132 Row house with 5 flats or more | 2 | 200.0 | 186.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 15 Block of flats | 10 | 200.3 | 184.8 | 74.7 | 25.3 | 0.0 | 0.0 | 0.0 |
| 151 Block of flats with 2 floors | 2 | 169.0 | 159.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 152 Block of flats with 3 and 4 floors | 4 | 193.3 | 176.3 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 153 Block of flats with 5 or more floors | 4 | 223.0 | 206.3 | 43.4 | 56.6 | 0.0 | 0.0 | 0.0 |
| 2 Manufacturing-and storehouses | 21 | 294.1 | 271.7 | 42.6 | 47.0 | 10.3 | 0.0 | 0.0 |
| 21 Industribygning | 9 | 346.0 | 321.3 | 46.2 | 33.4 | 20.4 | 0.0 | 0.0 |
| 212 Verkstedsbygning | 8 | 366.5 | 340.5 | 42.9 | 35.5 | 21.6 | 0.0 | 0.0 |
| 213 Produksjonshall | 1 | 182.0 | 168.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |

| | | | | | | | | |
|---------------------------------------------------------|------------|--------------|--------------|-------------|-------------|------------|------------|------------|
| 23 Lagerbygning | 12 | 255.3 | 234.5 | 39.0 | 61.0 | 0.0 | 0.0 | 0.0 |
| 231 Lagerhall | 11 | 255.7 | 234.4 | 40.8 | 59.2 | 0.0 | 0.0 | 0.0 |
| 239 Annen lagerbygning | 1 | 250.0 | 236.0 | 19.1 | 80.9 | 0.0 | 0.0 | 0.0 |
| 3 Offices and commercial buildings | 180 | 286.7 | 270.3 | 88.9 | 4.6 | 5.9 | 0.0 | 0.5 |
| 31 Office building | 143 | 229.1 | 213.7 | 84.5 | 6.8 | 7.7 | 0.0 | 0.8 |
| 311 Office/ administration building, city hall | 101 | 219.9 | 205.6 | 86.8 | 8.5 | 3.9 | 0.0 | 0.6 |
| 312 Bank building, post office | 6 | 209.2 | 197.5 | 99.7 | 0.4 | 0.0 | 0.0 | 0.0 |
| 319 Other office building | 34 | 259.4 | 240.2 | 75.8 | 3.6 | 19.0 | 0.0 | 1.6 |
| 32 Commercial building | 37 | 509.4 | 489.1 | 96.3 | 0.9 | 2.8 | 0.0 | 0.0 |
| 321 Shopping centre, department store | 22 | 551.5 | 527.2 | 99.4 | 0.6 | 0.0 | 0.0 | 0.0 |
| 322 Shop building | 6 | 590.5 | 576.7 | 97.3 | 2.7 | 0.0 | 0.0 | 0.0 |
| 329 Other commercial buildings | 9 | 352.4 | 337.4 | 83.3 | 0.0 | 16.7 | 0.0 | 0.0 |
| 4 Communication- and transport building | 34 | 366.9 | 337.9 | 83.4 | 14.5 | 2.1 | 0.0 | 0.0 |
| 41 General office- and terminal building | 24 | 398.4 | 366.6 | 93.3 | 5.1 | 1.5 | 0.0 | 0.0 |
| 411 General office, flight terminal, control tower | 5 | 509.0 | 483.8 | 99.6 | 0.4 | 0.0 | 0.0 | 0.0 |
| 412 Railways | 13 | 405.2 | 366.1 | 90.2 | 7.0 | 2.9 | 0.0 | 0.0 |
| 415 Goods terminal | 1 | 327.0 | 298.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 416 Post terminal | 5 | 284.2 | 264.4 | 91.8 | 8.2 | 0.0 | 0.0 | 0.0 |
| 43 Garage- and hangar building | 6 | 298.3 | 280.7 | 30.8 | 69.2 | 0.0 | 0.0 | 0.0 |
| 432 Bus garage, streetcar building, locomotive building | 1 | 120.0 | 106.0 | 65.1 | 34.9 | 0.0 | 0.0 | 0.0 |
| 433 Aircraft hangar | 5 | 334.0 | 315.6 | 28.5 | 71.5 | 0.0 | 0.0 | 0.0 |
| 44 Road- and car supervision building | 4 | 280.8 | 251.8 | 84.4 | 4.6 | 11.0 | 0.0 | 0.0 |
| 441 Car supervision building | 3 | 301.7 | 270.0 | 80.6 | 5.7 | 13.7 | 0.0 | 0.0 |
| 442 Working central | 1 | 218.0 | 197.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 5 Hotel and restaurant building | 55 | 275.7 | 266.5 | 51.7 | 46.6 | 1.6 | 0.1 | 0.0 |
| 51 Hotel building | 12 | 313.8 | 302.2 | 82.2 | 10.8 | 6.6 | 0.3 | 0.0 |
| 511 Hotel building | 12 | 313.8 | 302.2 | 82.2 | 10.8 | 6.6 | 0.3 | 0.0 |
| 52 Building for overnight stop | 35 | 215.4 | 208.3 | 36.9 | 63.1 | 0.0 | 0.0 | 0.0 |
| 523 Barracks | 19 | 187.4 | 181.4 | 33.4 | 66.6 | 0.0 | 0.0 | 0.0 |
| 529 Other building for overnight stop | 15 | 251.3 | 242.8 | 36.7 | 63.3 | 0.0 | 0.0 | 0.0 |
| 53 Restaurant building | 8 | 482.3 | 467.4 | 50.8 | 49.2 | 0.0 | 0.0 | 0.0 |
| 531 Restaurant building, café building | 1 | 381.0 | 365.0 | 100.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 532 Central kitchen, canteen building | 7 | 496.7 | 482.0 | 45.5 | 54.5 | 0.0 | 0.0 | 0.0 |

continues next page

Table. C'td Measurements of energy consumption in Norwegian buildings in kWh/m² heated area, year 2000 (source: ENOVAS in Statistics Norway 2005)

| Type of building | # | energy corrected (kWh/m ²) | energy (kWh/m ²) | energy-split | | | | |
|--------------------------------------------------|------------|----------------------------------------|------------------------------|-------------------|------------|------------|------------|------------|
| | | | | Elec- tricity (%) | Oil (%) | Heat (%) | Gas (%) | Other (%) |
| 6 Cultural- and research building | 595 | 215.2 | 197.5 | 87.6 | 7.5 | 4.9 | 0.0 | 0.1 |
| 61 School building | 479 | 198.7 | 182.2 | 90.8 | 7.5 | 1.6 | 0.0 | 0.1 |
| 611 Kindergarten, playground | 48 | 232.6 | 211.0 | 98.9 | 1.1 | 0.0 | 0.0 | 0.0 |
| 612 Primary school | 292 | 197.5 | 180.7 | 91.6 | 7.4 | 0.9 | 0.0 | 0.0 |
| 613 College | 129 | 187.3 | 173.5 | 86.5 | 9.3 | 4.1 | 0.0 | 0.0 |
| 619 Other school building | 8 | 210.4 | 191.3 | 81.4 | 18.6 | 0.0 | 0.0 | 0.0 |
| 62 University and academy building | 50 | 287.2 | 261.6 | 70.8 | 3.9 | 25.3 | 0.0 | 0.0 |
| 621 Building with integrated functions and so on | 40 | 294.1 | 269.2 | 69.5 | 2.6 | 27.9 | 0.0 | 0.0 |
| 622 Special building | 6 | 282.8 | 250.5 | 80.3 | 4.7 | 15.1 | 0.0 | 0.0 |
| 629 Other University and academy building | 4 | 224.3 | 203.0 | 69.8 | 19.6 | 10.6 | 0.0 | 0.0 |

| | | | | | | | | |
|-----------------------------------------------------|------------|--------------|--------------|-------------|-------------|------------|------------|------------|
| 64 Museum- and library building | 6 | 200.8 | 187.2 | 69.5 | 12.6 | 17.8 | 0.0 | 0.0 |
| 641 Museum, art gallery | 3 | 217.3 | 203.0 | 62.9 | 4.3 | 32.8 | 0.0 | 0.0 |
| 642 Library | 3 | 184.3 | 171.3 | 77.4 | 22.6 | 0.0 | 0.0 | 0.0 |
| 65 Sports building | 43 | 317.7 | 295.7 | 82.8 | 12.2 | 5.0 | 0.0 | 0.0 |
| 651 Sports building | 28 | 242.7 | 222.1 | 82.4 | 13.6 | 4.0 | 0.0 | 0.0 |
| 652 Ice building | 1 | 272.0 | 244.0 | 67.6 | 32.4 | 0.0 | 0.0 | 0.0 |
| 653 Swimming hall | 13 | 478.3 | 455.2 | 84.1 | 9.4 | 6.5 | 0.0 | 0.0 |
| 659 Other sports building | 1 | 375.0 | 336.0 | 80.7 | 19.3 | 0.0 | 0.0 | 0.0 |
| 66 Culture house | 13 | 226.5 | 210.0 | 90.9 | 3.7 | 5.5 | 0.0 | 0.0 |
| 661 Cinema, theatre, opera/consert hous | 3 | 177.7 | 166.3 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 662 Community centre | 6 | 247.5 | 226.8 | 89.1 | 0.0 | 10.9 | 0.0 | 0.0 |
| 663 Discoteque, youth club | 1 | 398.0 | 389.0 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 669 Other cultural building | 3 | 176.3 | 160.3 | 79.2 | 20.8 | 0.0 | 0.0 | 0.0 |
| 67 Building with religious activities | 3 | 196.7 | 165.3 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 671 Church, chapel | 3 | 196.7 | 165.3 | 100.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 69 Other cultural- and research building | 1 | 94.0 | 87.0 | 96.6 | 3.4 | 0.0 | 0.0 | 0.0 |
| 7 Health buildings | 135 | 297.3 | 278.0 | 91.8 | 6.8 | 0.3 | 0.5 | 0.6 |
| 71 Hospital | 15 | 330.9 | 309.1 | 67.7 | 26.3 | 0.0 | 4.1 | 1.8 |
| 711 Local hospital | 3 | 316.0 | 295.7 | 76.1 | 23.9 | 0.0 | 0.0 | 0.0 |
| 712 Central hospital | 6 | 360.8 | 336.2 | 79.5 | 11.0 | 0.0 | 9.5 | 0.0 |
| 714 Special hospital | 3 | 351.0 | 331.3 | 66.3 | 25.4 | 0.0 | 0.0 | 8.4 |
| 719 Other hospital | 3 | 265.7 | 246.0 | 27.6 | 72.4 | 0.0 | 0.0 | 0.0 |
| 72 Nursing home | 111 | 300.2 | 281.3 | 95.4 | 3.9 | 0.3 | 0.0 | 0.4 |
| 721 Nursing home | 82 | 305.6 | 286.9 | 96.5 | 3.1 | 0.3 | 0.0 | 0.0 |
| 722 Live- and treatment centre | 25 | 286.4 | 267.3 | 93.1 | 6.9 | 0.0 | 0.0 | 0.0 |
| 729 Other nursing home | 4 | 276.0 | 254.5 | 84.3 | 1.1 | 2.1 | 0.0 | 12.6 |
| 73 Primary health building | 9 | 205.9 | 185.6 | 91.5 | 7.7 | 0.8 | 0.0 | 0.0 |
| 732 Health centre, maternal and child health centre | 8 | 213.8 | 192.0 | 91.6 | 8.4 | 0.0 | 0.0 | 0.0 |
| 739 Other primary health building | 1 | 143.0 | 134.0 | 90.3 | 0.0 | 9.7 | 0.0 | 0.0 |
| 8 Prisons, emergency buildings etc. | 6 | 228.0 | 210.8 | 81.4 | 15.5 | 3.1 | 0.0 | 0.0 |
| 82 Standby building | 6 | 228.0 | 210.8 | 81.4 | 15.5 | 3.1 | 0.0 | 0.0 |
| 821 Police station | 5 | 235.6 | 216.2 | 93.2 | 3.1 | 3.6 | 0.0 | 0.0 |
| 829 Other standby building | 1 | 190.0 | 184.0 | 12.0 | 88.0 | 0.0 | 0.0 | 0.0 |

Table . Sweden: Energy statistics for non-residential premises 2005; Number of premises and properties in 2005 by type of premise and size of area, 1000s

| Typ av lokal | Area | | | | | | | | | |
|--------------------------------|--------------|--------------|---------------|------|----------------|------|------------|-----|--------------|--------------|
| | 200 – 999 | | 1 000 – 4 999 | | 5 000 – 19 999 | | 20 000 – | | Samtliga | |
| Bostäder | 5.883 | ± 359 | 743 | ± 85 | 221 | ± 46 | 17 | | 6.863 | ± 370 |
| Hotell, restaurang, elevhem | 4.538 | ± 295 | 1.344 | | 254 | ± 29 | 17 | | 6.154 | ± 309 |
| därav restaurang | 3.216 | ± 243 | 203 | ± 45 | 13 | ± | – | | 3.433 | ± 246 |
| Kontor och förvaltning | 10.88 | ± 466 | 4.491 | | 1.323 | ± 76 | 250 | | 16.95 | ± 497 |
| Livsmedelshandel | 2.554 | ± 251 | 1.015 | | 153 | ± 21 | 9 | | 3.730 | ± 272 |
| Övrig handel | 5.228 | ± 330 | 2.329 | | 405 | ± 36 | 33 | ± 4 | 7.996 | ± 354 |
| Vård, dygnet runt | 1.608 | ± 134 | 1.152 | | 384 | ± 62 | 110 | | 3.253 | ± 168 |
| Vård, dagtid | 1.949 | ± 147 | 1.119 | ± 97 | 227 | ± 40 | 16 | | 3.312 | ± 175 |
| Skolor (förskola – univ) | 5.587 | ± 212 | 4.489 | | 1.960 | ± | 167 | | 12.20 | ± 228 |
| Bad-, sport-, idrottsanl. | 1.938 | ± 162 | 1.280 | | 198 | ± 47 | .. | | 3.441 | ± 193 |
| Kyrkor, kapell | 4.551 | ± 306 | 560 | | – | ± | – | | 5.110 | ± 312 |
| Teater, konsert, biograf | 4.043 | ± 280 | 912 | | 188 | ± 49 | 32 | | 5.174 | ± 302 |
| Varmgarage | 1.708 | ± 181 | 409 | ± 75 | 95 | ± 18 | – | | 2.212 | ± 197 |
| Övriga lokaler | 2.572 | ± 231 | 823 | | 182 | ± 51 | .. | | 3.586 | ± 261 |
| Samtliga lokaler | 56.26 | ± 1 | 20.86 | | 5.603 | | 686 | | 83.42 | ± 1 |
| Samtliga fastigheter | 27.68 | ± 605 | 18.43 | | 6.026 | | 855 | | 53.00 | ± 610 |

Table . UK Final energy consumption in the service sector by sub-sector and end use, 2004. In 1000 toe

| Group | Catering | Compu- ting | Cooling & Ventila- tion | Hot water | Heating | Lighting | Other | Total (1) |
|--------------------------------|--------------|----------------|-------------------------------|--------------|--------------|--------------|--------------|---------------|
| Commercial Offices | 52 | 117 | 168 | 129 | 1.166 | 253 | 48 | 1.934 |
| Communication and Transport | 37 | 9 | 30 | 34 | 143 | 214 | 89 | 557 |
| Education | 149 | 53 | 7 | 216 | 1.189 | 223 | 76 | 1.913 |
| Government | 82 | 53 | 23 | 90 | 819 | 81 | 53 | 1.201 |
| Health | 38 | 9 | 0,74 | 122 | 709 | 130 | 18 | 1.027 |
| Hotel and Catering | 738 | 6 | 103 | 565 | 1.139 | 308 | 113 | 2.971 |
| Other | 45 | 14 | 18 | 103 | 714 | 136 | 72 | 1.102 |
| Retail | 507 | 122 | 321 | 220 | 1.559 | 1.227 | 293 | 4.248 |
| Sport and Leisure | 95 | 11 | 45 | 195 | 448 | 149 | 176 | 1.119 |
| Warehouses | 202 | 35 | 54 | 114 | 1.606 | 425 | 260 | 2.695 |
| Total | 1.945 | 429 | 771 | 1.788 | 9.493 | 3.146 | 1.198 | 18.769 |

1. The Total does not include Heat Sold and Renewables

Source: Building Research Establishment

Table . Netherlands: New building permits 2000-2009

| Period | Value mlneuro | Number | Volume 1000m ³ | Period | Value mlneuro | Number | Volume 1000m ³ |
|-----------------------------------------|------------------|--------|------------------------------|----------------------------------|------------------|--------|------------------------------|
| <u>Totaal gebouwen</u> | | | | <u>Kassen</u> | | | |
| 2000 | 13.165 | 21.723 | 137.322 | 2000 | 142 | 328 | 23.712 |
| 2005 | 14.951 | 16.560 | 119.743 | 2005 | 113 | 187 | 22.410 |
| 2006 | 18.084 | 18.042 | 143.070 | 2006 | 137 | 172 | 27.799 |
| 2009 | 16.013 | 13.759 | 107.401 | 2009 | 46 | 69 | 7.465 |
| <u>Woongebouwen</u> | | | | <u>Schuren en stallen</u> | | | |
| 2000 | 7.170 | 13.917 | 38.960 | 2000 | 309 | 1.862 | 10.695 |
| 2005 | 10.093 | 11.749 | 44.540 | 2005 | 372 | 1.447 | 10.765 |
| 2006 | 11.984 | 12.746 | 51.537 | 2006 | 446 | 1.731 | 13.483 |
| 2009 | 9.845 | 8.817 | 38.552 | 2009 | 629 | 1.835 | 16.399 |
| <u>Totaal bedrijfsgebouwen</u> | | | | <u>Winkels</u> | | | |
| 2000 | 5.995 | 7.806 | 98.362 | 2000 | 126 | 164 | 1.318 |
| 2005 | 4.857 | 4.811 | 75.203 | 2005 | 125 | 72 | 1.223 |
| 2006 | 6.100 | 5.296 | 91.533 | 2006 | 113 | 100 | 826 |
| 2009 | 6.168 | 4.942 | 68.849 | 2009 | 84 | 76 | 616 |
| <u>Hallen en Loodsen</u> | | | | <u>Scholen</u> | | | |
| 2000 | 643 | 1.339 | 22.636 | 2000 | 270 | 248 | 1.732 |
| 2005 | 355 | 615 | 13.220 | 2005 | 515 | 193 | 2.613 |
| 2006 | 507 | 758 | 17.095 | 2006 | 607 | 179 | 2.905 |
| 2009 | 480 | 645 | 14.172 | 2009 | 481 | 179 | 2.180 |
| <u>Kantoren</u> | | | | <u>Overige gebouwen</u> | | | |
| 2000 | 1.724 | 691 | 8.495 | 2000 | 1.392 | 1.430 | 8.942 |
| 2005 | 714 | 257 | 3.201 | 2005 | 1.651 | 903 | 7.950 |
| 2006 | 1.017 | 299 | 3.889 | 2006 | 2.086 | 863 | 10.043 |
| 2009 | 945 | 246 | 3.608 | 2009 | 2.315 | 892 | 9.563 |
| <u>Combinatie bedrijfshallen</u> | | | | | | | |
| 2000 | 1.389 | 1.744 | 20.833 | | | | |
| 2005 | 1.012 | 1.137 | 13.820 | | | | |
| 2006 | 1.186 | 1.194 | 15.494 | | | | |
| 2009 | 1.189 | 1.000 | 14.847 | | | | |

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Residential

Table. Dwellings in EU-25 by type of fuel.

| | '000 dwellings heated by ... | | | | | % of total dwelling heated by ... | | | |
|-------------------|------------------------------------------------------|--------------|-------------|-------------|-----------------|------------------------------------------------------|------------|-------------|-----------|
| | (individual wet systems and collective systems only) | | | | | (individual wet systems and collective systems only) | | | |
| | gas | oil | electric | solid | total dwellings | gas | oil | electric | solid |
| Austria | 958 | 1022 | 58 | 420 | 4020 | 24% | 25% | 1,4% | 10% |
| Belgium | 1400 | 1090 | | 59 | 3724 | 38% | 29% | | 2% |
| Cyprus | | | | | | | | | |
| CzechRep. | 1364 | 63 | 11 | 511 | 3994 | 34% | 2% | 0,3% | 13% |
| Denmark | 342 | 445 | 13 | 51 | 2800 | 12% | 16% | 0,5% | 2% |
| Estonia | 33 | 70 | 3 | 14 | 622 | 5% | 11% | 0,5% | 2% |
| Finland | 20 | 512 | 46 | 322 | 2871 | 1% | 18% | 1,6% | 11% |
| France | 10418 | 7739 | 86 | 492 | 30218 | 34% | 26% | 0,3% | 2% |
| Germany | 14500* | 15024* | 66 | 128 | 38398 | 38% | 39% | 0,2% | 0% |
| Greece | 78 | 2630 | | 100 | 5650 | 1% | 47% | | 2% |
| Hungary | 1421 | 4 | | 173 | 4173 | 34% | 0% | | 4% |
| Ireland | 470 | 520 | 37 | 197 | 1370 | 34% | 38% | 2,7% | 14% |
| Italy | 15238 | 5340 | 89 | 79 | 27941 | 55% | 19% | 0,3% | 0% |
| Latvia | 80 | 125 | | 74 | 965 | 8% | 13% | | 8% |
| Lithuania | 108 | 82 | | 145 | 1304 | 8% | 6% | | 11% |
| Luxembourg | | | | | | | | | |
| Malta | | | | | | | | | |
| Netherlands | 5909 | 129 | 9 | 50 | 6810 | 87% | 2% | 0,1% | 1% |
| Poland | 1841 | 822 | | 1761 | 12683 | 15% | 6% | | 14% |
| Portugal | 191 | 64 | | 22 | 5271 | 4% | 1% | | 0% |
| Slovakia | 551 | 0 | | 241 | 1899 | 29% | 0% | | 13% |
| Slovenia | 78 | 265 | | 166 | 796 | 10% | 33% | | 21% |
| Spain | 4312 | 3108 | | 345 | 22098 | 20% | 14% | | 2% |
| Sweden | 89 | 717 | 1038 | 467 | 5060 | 2% | 14% | 20,5% | 9% |
| UK | 19763 | 1189 | 587 | 385 | 25055 | 79% | 5% | 2,3% | 2% |
| TOTAL EU22 | 79168 | 40956 | 2043 | 6202 | 207728 | 38% | 20% | 1,0% | 3% |
| | 62% | 32% | 2% | 5% | | | | | |

* note that boiler stock data are slightly different from data Statistisches Bundesamt: There 11,2 mln. oil, 16,75 mln. gas on a total of 35,1 mln. conventional occupied dwellings (excl. coll. Homes) for Germany 2002.

Comfort issues

Most, if not all, building regulations prescribe the room temperatures that are to be achieved during the coldest day. For the living room this is often 20 to 22°C, for the kitchen and bedroom this is often 18°C.

These values are of course design values. For heat loss calculations one can use these design values or an overall average room temperature as the Dutch EPN does (with a daily average indoor temperature of 18°C). The German PassivHause-concept calculates with 20°C due to ventilation with heat recovery and no nighttime reduction (because of very high insulation level). This raises the question whether in modern dwellings (with ventilation with heat recovery and no nighttime reduction) one should calculate with 18°C.³³

Besides calculating with design temperatures one can also use the real-life values. Some sources recommend lower temperatures than the regulations mention, see the example below by www.wasserwaermeluft.de (Standard DIN4701 between brackets)³⁴

The temperature in the living room should be 20°C average (20°C);

For the bedroom 16 - 17°C (20°C) suffices for a healthy sleeping environment;

The children's room can be kept at average 20°C (20°C);

The bathroom should be kept warm at 22°C (24°C);

In the kitchen a temperature of 18°C (20°C) suffices, due to the extra heat produced by cooking.

³³ <http://www.passiefhuis.nl/images/Artikel-06-2006.pdf>

³⁴ <http://www.wasserwaermeluft.de/b2c/waerme/heizung/index.html>