Ventilation products regulations based on Ecodesign directive

ongoing study Ecodesign ENTR Lot 6 (Tasks 1-5)

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REHVA Technical Seminar

on Buildings Related EU Regulations and Projects Brussels,
Brussels, 27.10.2011

Ecodesign Preparatory Study (Dir. 2009/125/EC)

ENTR Lot 6: Air-conditioning and ventilation systems

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

Service Contract to European Commission, DG Enterprise

Sustainable Industrial Policy –

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

Main contractor: Armines (FR)

Consortium:

Armines (FR), Air Conditioning Systems rapporteur

VHK (NL), Ventilation Systems rapporteur

BRE (UK), market analysis support

Key Questions for Preparatory Study

Is product group eligible for Ecodesign measures?

- Economically significant
- Environmental impact significant
- Saving potential, taking into account also existing other policies and avoidance of significant negative impacts

If eligible, what are appropriate, possible

- Requirements/ targets
- Test & calculation methods/standards for targets
- Implementation dates (timing)

and what are

- Future impacts expected from measures (economical, environmental, jobs, etc.; time frame 2020-2025)

Stakeholder Consultation

Project website : www.ecohvac.eu

- Since Jan. 2010
- Registration of stakeholders (>270 to date)

Stakeholder meetings

- 1^{st} in June 2010
- 2 more to follow: summer 2011 and end 2011/beginning 2012

Draft reports

- Task 1-5 draft reports air conditioning part
- Task 1-5 draft reports ventilation system part (2.5.2011)

Written consultation

- Via feedback form on website stakeholders can deliver comments

Planning and Tasks

May 2011

Start: Jan. 2010

Task 1: Scope, Legislation, Standards

Task 2: Economics, Markets

Task 3: Usage, Infra-structure

Task 4: LCA & LCC Base Cases

Task 5: Technical analysis

End study: Dec. 2011 (estimate)

Task 6: Design Options, LLCC Targets

Task 7: Policy-Scenario-Sensitivity-Analysis

European Commission legislative process:
Working Documents
Inter Service Consultation
Commission Impact Analysis
etc.

Task 1: Product Scope Ventilation Systems

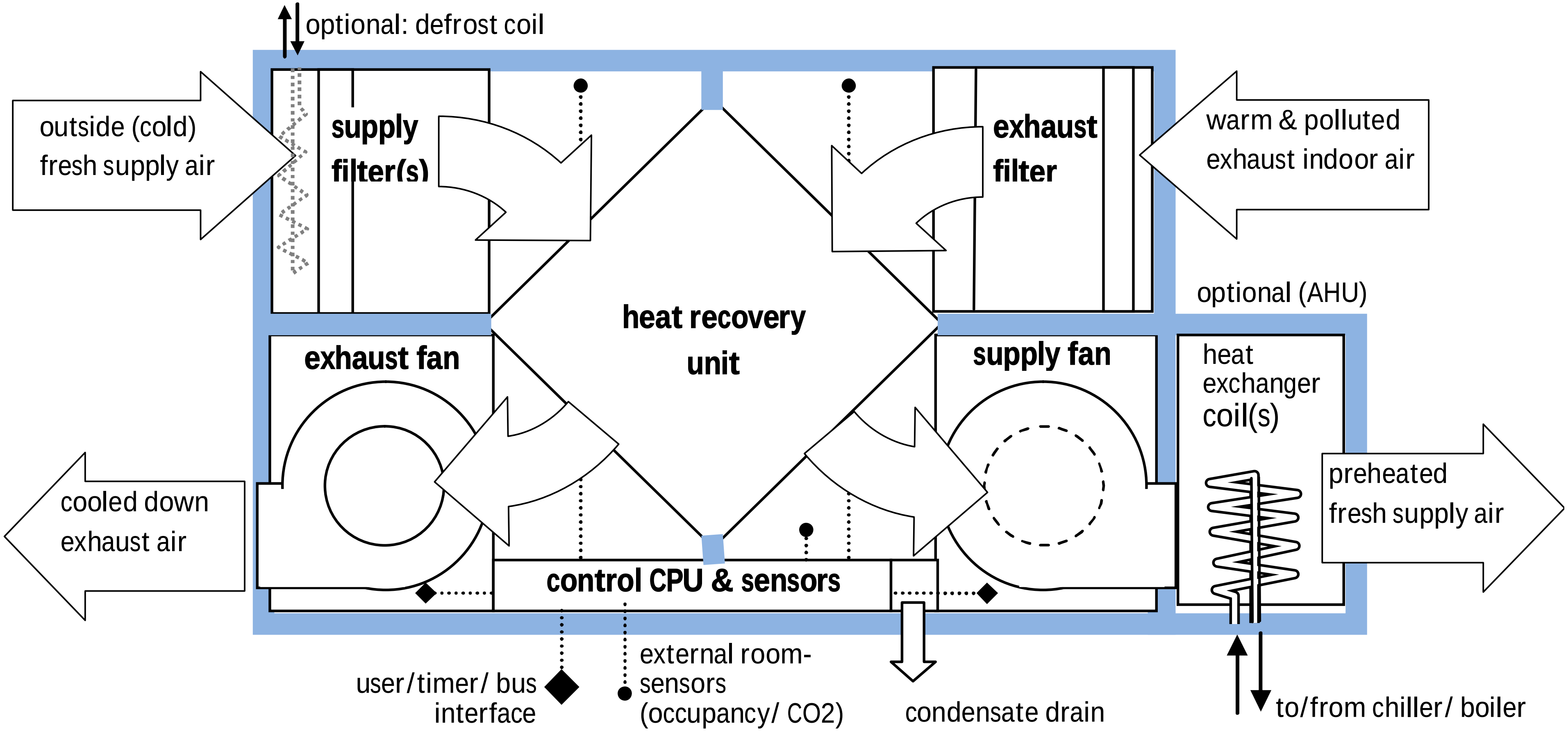
Mechanical ventilation units with nominal electric power input per fan larger than 125 W:

- single fan exhaust (or supply) units (CEXH)
- double-fan balanced units:
  - air handling units (AHU)
  - central heat recovery units (CHRV)

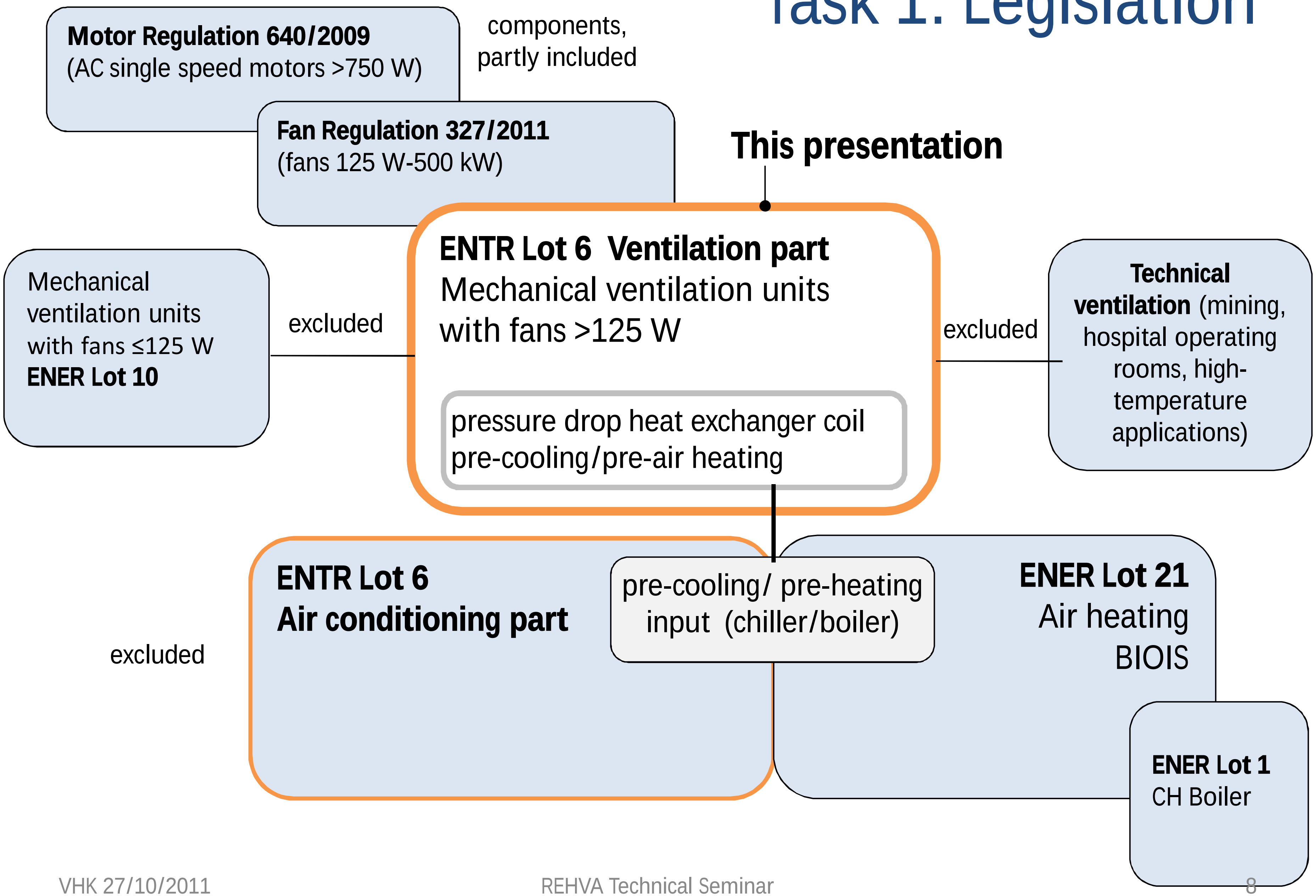
Included in analysis: fan(s), casing, controls, heat recovery, internal pressure drop (e.g. inlet, outlet, filter, coil)
Excluded: ducts, dividers, terminal units. (de)humidifier functionality [new item]

Task 1: Product Scope c'td

Example balanced HR units



Task 1: Legislation



Task 1: Test standards, Key Requirements

The ideal performance test method for use in Ecodesign legislation:

- Comprehensive & fair (compares 'apples with apples' and not 'apples with pears'; level playing field for competition)
- Realistic (reflects real-life operation as much as possible)
- Accurate & reproducible results (robust for legal ends)
- Limited costs & feasible surveillance (for industry and MS)
- Consistent with adjacent product categories (e.g. ventilation units with fans <125 W in ENER 10)

Task 1: Test Standard Issues [1]

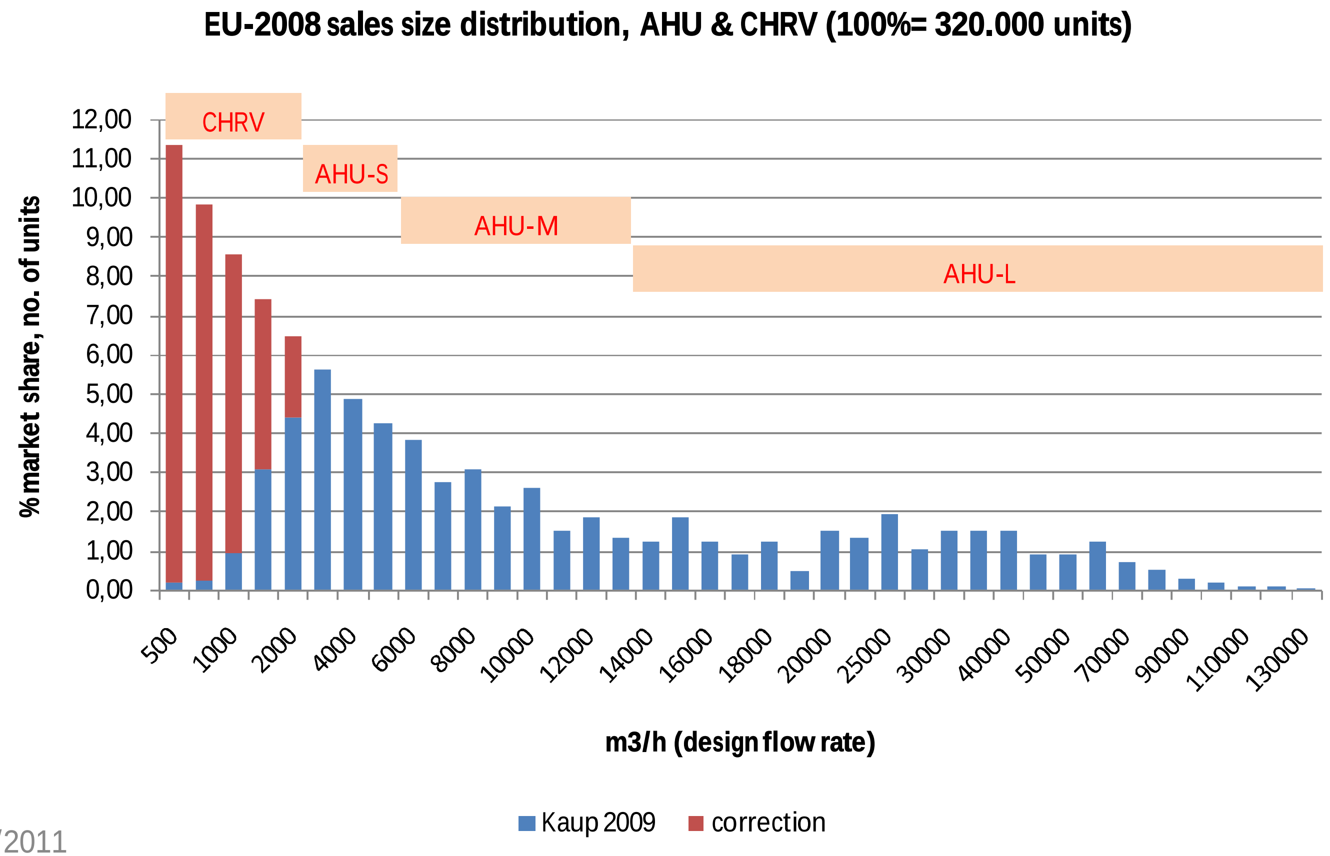
- Product scope is **both** non-residential and (collective) residential ventilation→ both give relevant standards
- Residential (prEN 13142, EN 13141-x etc.) and non-residential ventilation (EN 13053, EN 13779, etc.) have **different sets of test standards** for often the same issues. They overlap and are not always compatible/consistent.
- Specific Power Input **SPI** (residential) and Specific Fan Power **SFP** (non-residential) are both not complete. SPI is inexact as regards external pressure drop. SFP does not take into account differences in internal pressure drop and does not cover auxiliary energy.

Task 1: Test Standard Issues [2]

- **Heat recovery residential**: thermal efficiency (based on temperature differences in/outputs)
- **Heat recovery non-residential**: overall energy efficiency (thermal efficiency minus electricity consumption to overcome the heat exchanger pressure drop)
- **Testing units from small volume production**: Testing in lab vs. testing on-site. How and when?
- **Load** pattern (realistic) vs. single point test?
- **Filter** test and evaluation, problems testing electrostatic filters?
- **Sound**: In duct and/or casing radiated sound power
- Etc.

Task 2: Economics & Markets [1]

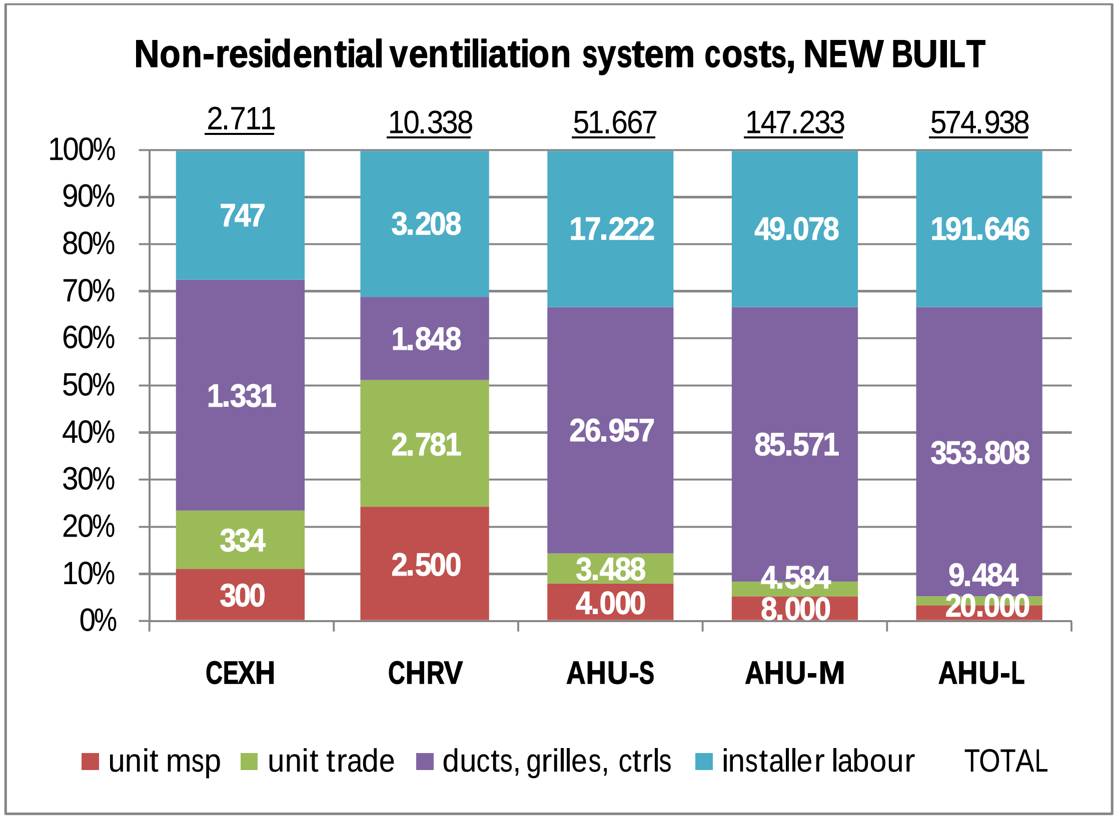
- Annual unit **EU-27 sales**: 1,1 mln. exhaust units and 0,32 mln. balanced (AHU& CHRV) units. **EU 27-stock**: 19 mln. units total.



Task 2: Economics & Markets [2]

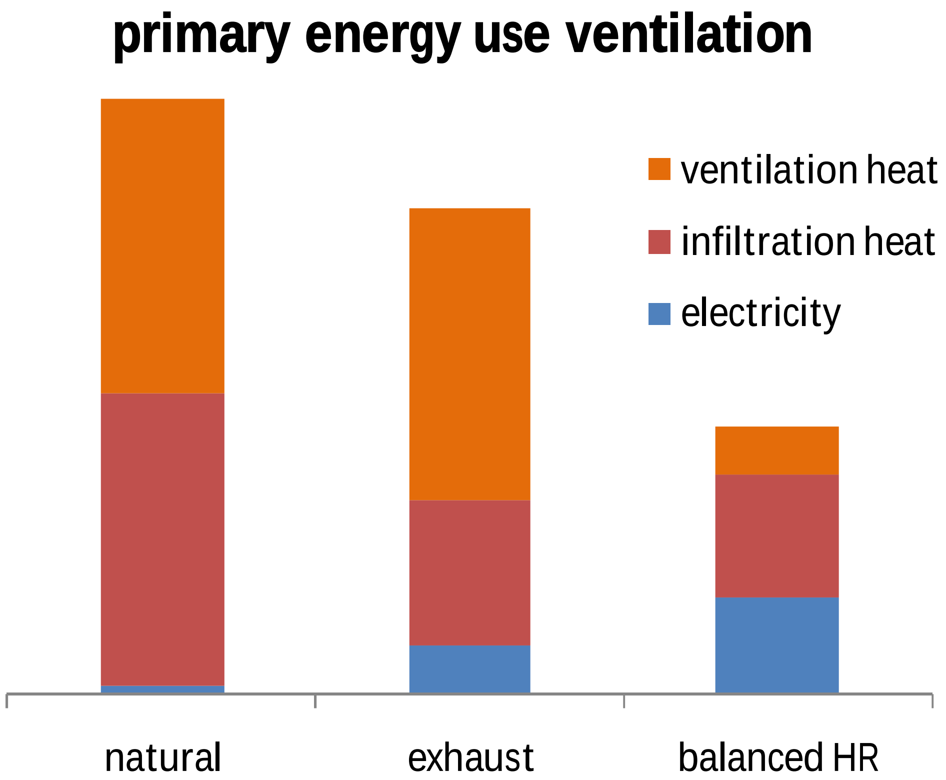
- **EU-27 industry revenue on ventilation units**: € 2,7 bln./a
- **EU-27 revenue on related installation products and services:** > € 37 bln./a.
- **Ex-EU imports ca. 15%**
- **Ex-EU exports ca. 15%**

Strong EU sector



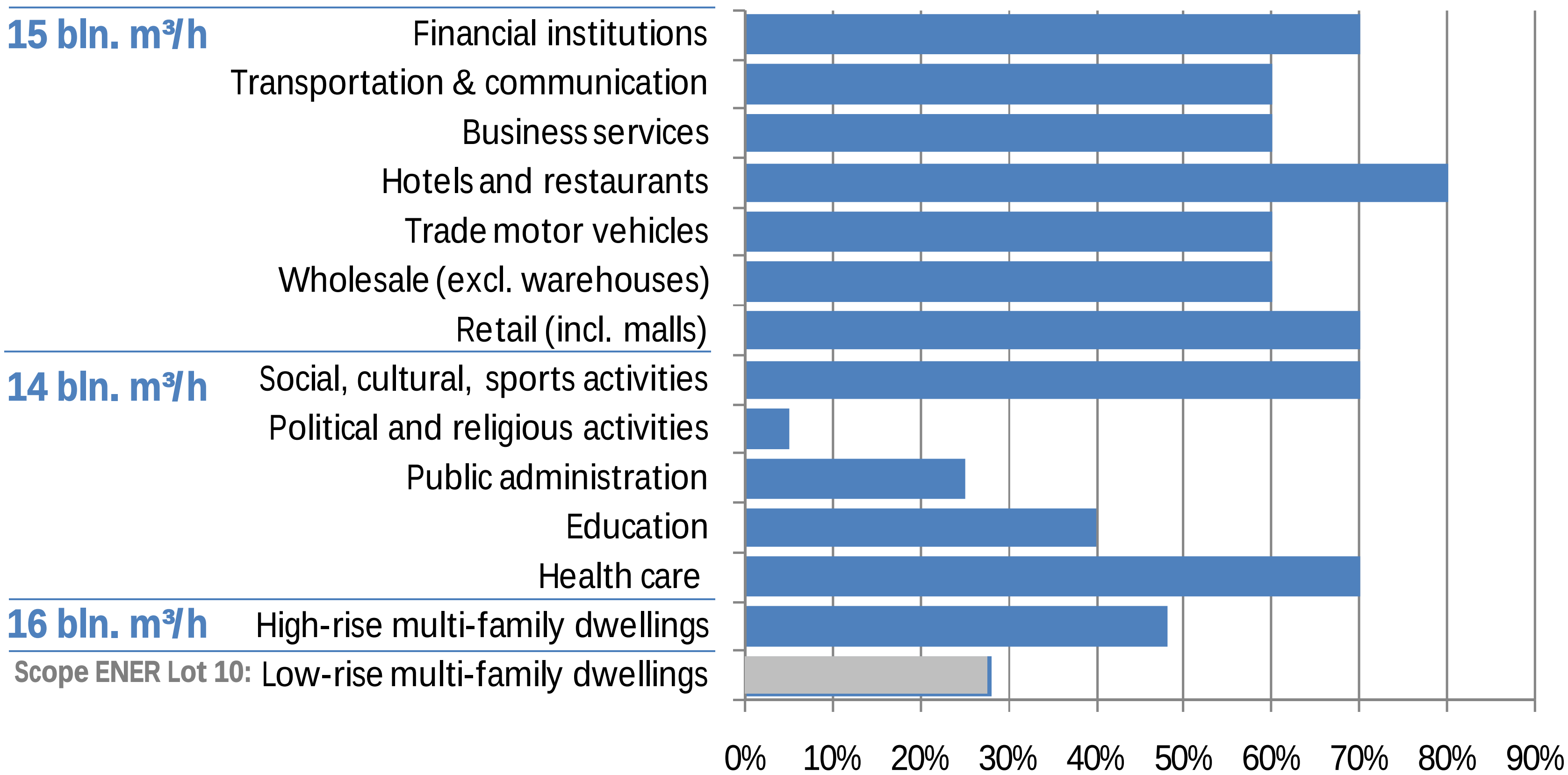
Task 3: Usage, Key Message

- **Mechanical ventilation indispensable in new efficient buildings (health)**
- **It costs electricity but can save up to 4 times as much primary energy in space heating (and cooling)**



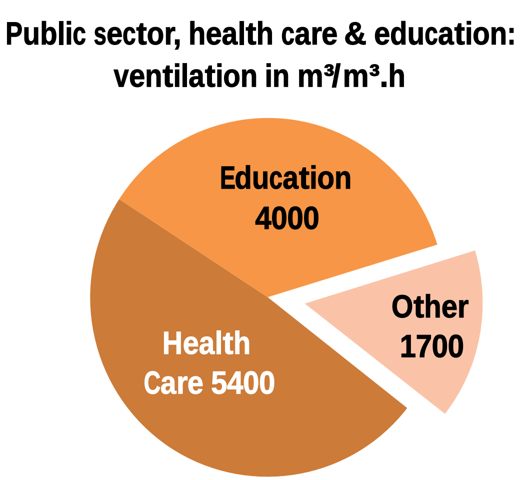
Task 3: Potential Mechanical Ventilation

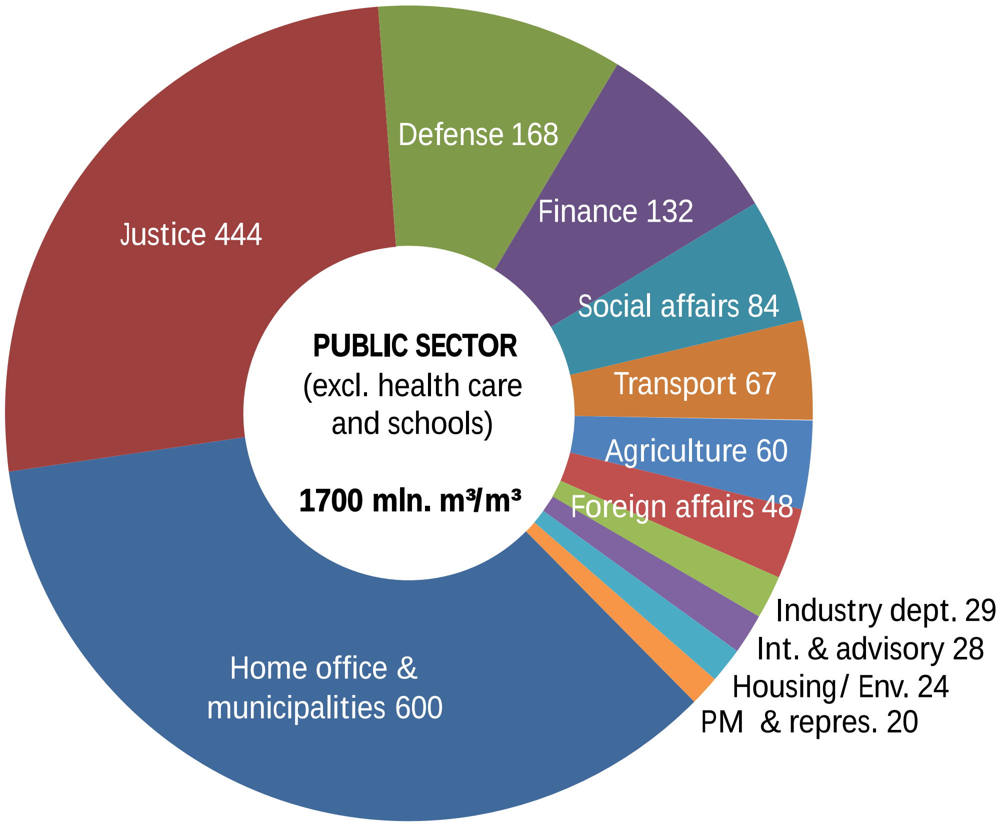
- **Total 68 bln. m³/h ventilation demand in scope, in EU-27** (incl. industry 23)
- **Large growth potential mechanical ventilation** (figure %=penetration rate)



Task 3: Potential Efficient Ventilation

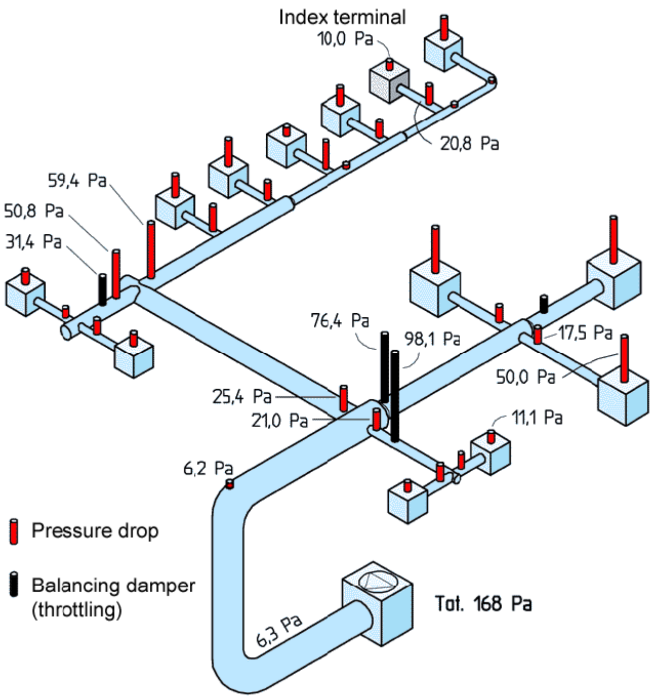
- **Balanced heat recovery ventilation still only 7% of total** (5 bln. m³/h)
- **Public sector buildings largest potential for efficient mech. ventilation**



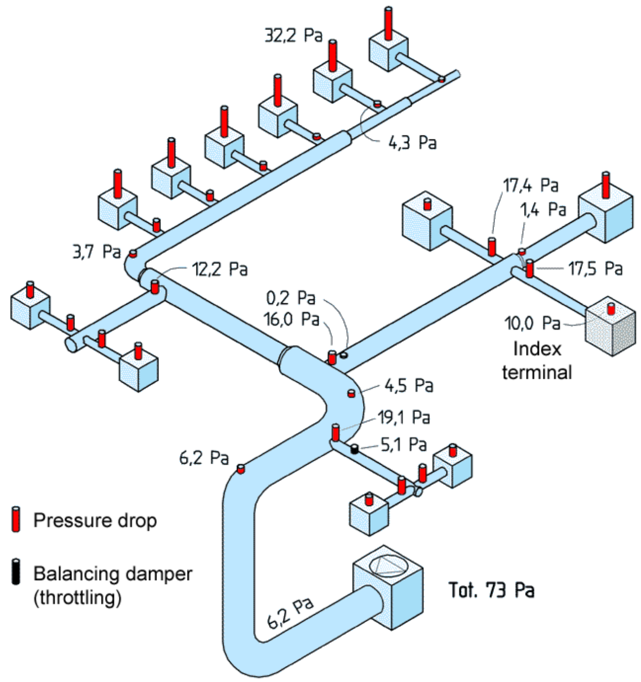


Task 3: Infra-structure

- **Ductwork and terminal units outside current scope of study, but large saving potential in reducing (external) pressure drop and fighting leakage**



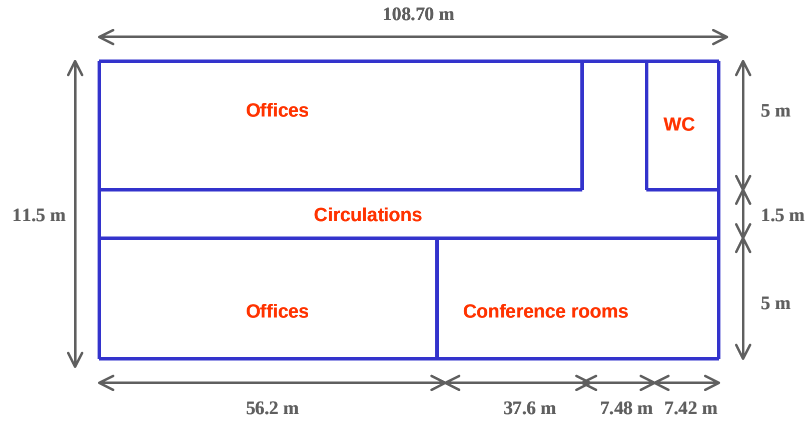
Poor design pressure drop **168 Pa**
(source: SINTEF)



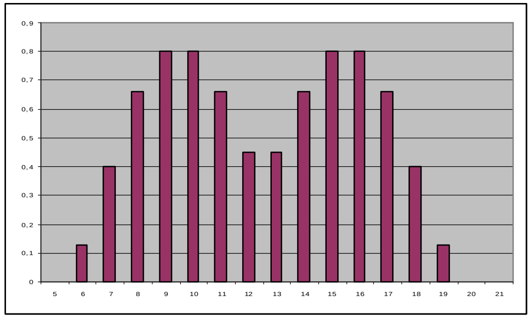
Good design pressure drop **73 Pa**
(source: SINTEF)

Task 3: Occupancy: Case Studies

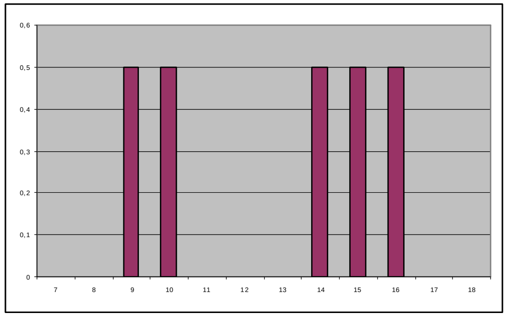
- Large office buildings (type 1)
- Medium-sized office building (type 2)
- Small office building (type 3)
- Hospital
- Retirement home
- Hotel
- Shopping mall
- Hypermarket



Overview Large office building



Occupancy Offices



Occupancy Conference Rooms

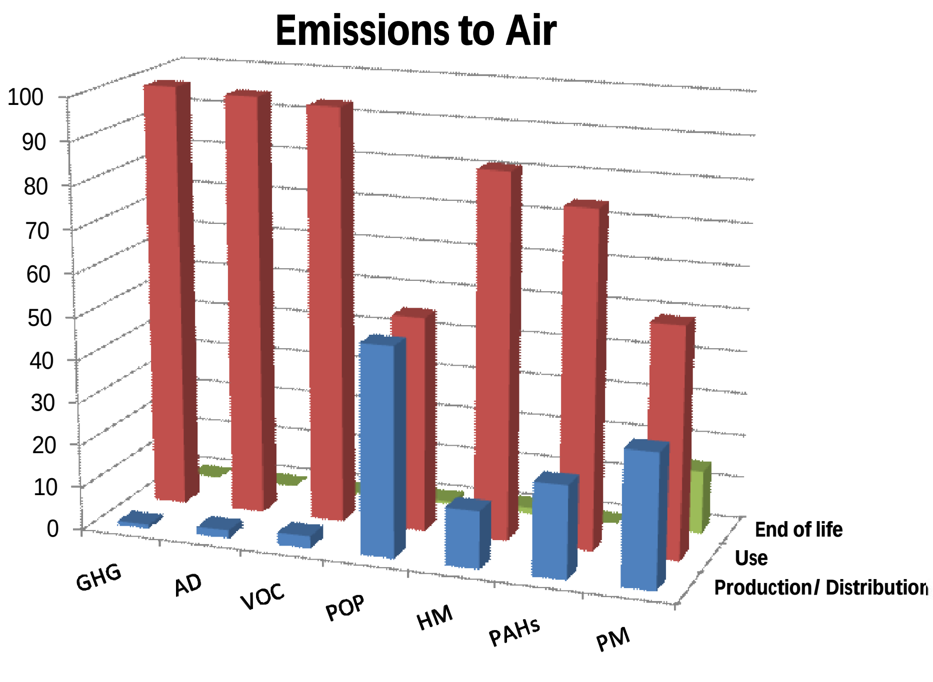
(data source: ARMINES)

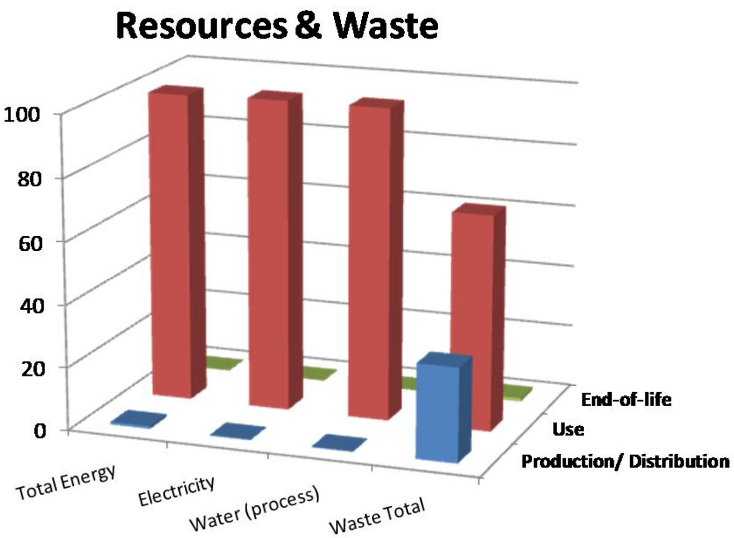
Task 3: Occupancy & Control Strategy

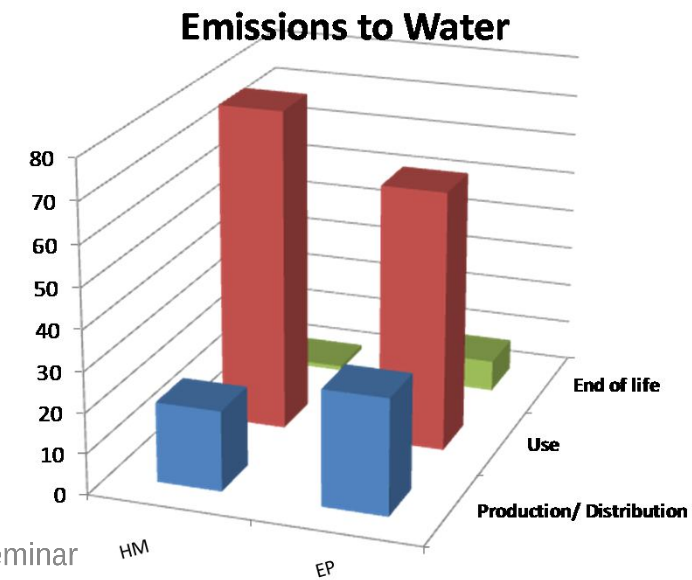
Avg. flow rate in 1000 m³/h	Office L	Office M	Office S	Hospital	Retirement home	Hotel	Shopping mall	Hypermarket
Design - fixed (technical)	*0*	*0*	*0*	*155*	*2*	*0*	*0*	*0*
Design - max. occupancy (ex pp/m2)	*46*	*15*	*3*	*25*	*6*	*17*	*145*	*33*
Total design flow (nominal)	***46***	***15***	***3***	***180***	***8***	***17***	***147***	***28***
Building best occupancy control (on-off)	***19***	***6***	***1***	***145***	***7***	***17***	***79***	***14***
Zone best occupancy control (on-off)	***19***	***6***	***1***	***145***	***5***	***10***	***62***	***12***
Zone best occupancy rate control (var.)	***10***	***3***	***0,6***	***131***	***3***	***3***	***14***	***2***
% of design flow	**22%**	**22%**	**22%**	**73%**	**41%**	**19%**	**10%**	**6%**

Task 4: Life Cycle Assessment (environmental)

- **Use phase dominant**



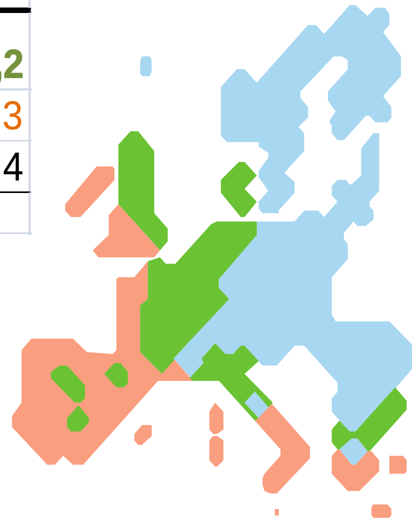




Task 4: Unit Running Costs 2010
(monetary, climate dependent)

- **Cost of electricity & maintenance and savings on heating fuel**

Unit Running Cost in 1000 EURO/a	CEXH	CHRV	AHU-S	AHU-M	AHU-L
Costs electricity	0,2	0,5	0,8	2,6	10,9
Maintenance	0,0	0,1	0,1	0,4	1,6
Heating fuel, Average climate	**-0,7**	**-3,0**	**-2,6**	**-6,5**	**-22,8**
Heating fuel, Warmer climate	-0,3	-1,4	-1,2	-3,0	-10,3
Heating fuel, Colder climate	-1,4	-5,6	-5,0	-12,6	-44,0
Total Average climate	**-0,5**	**-2,4**	**-1,8**	**-3,8**	**-11,2**
Total Warmer climate	-0,1	-0,8	-0,4	-0,2	1,3
Total Colder climate	-1,2	-5,1	-4,2	-9,8	-32,4



Task 4: Total EU27 –Expenditure 2010 (monetary)

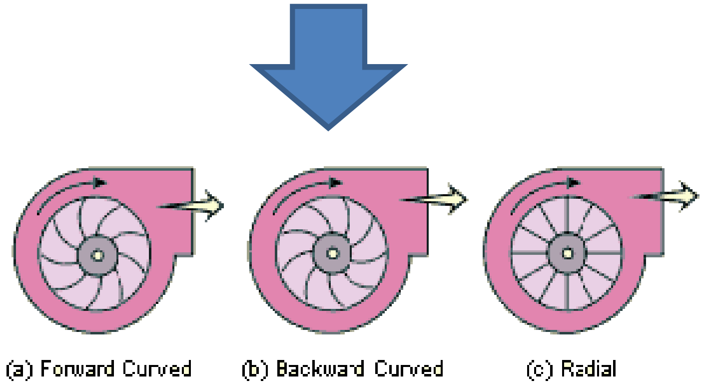
- **Acquisition costs of systems sold 2010 + Running costs stock 2010**

EU-27 expenditure 2010 in billion EURO/a	CEXH	CHRV	AHU-S	AHU-M	AHU-L	Total
Industry price (msp)	0,3	0,4	0,2	0,5	1,4	2,7
Installation & trade margins*	2,1	0,8	1,6	6,4	26,7	37,5
Electricity & maintenance	3,8	0,5	0,2	1,9	8,7	15,0
Heating fuel saved	-10,7	-2,6	-0,6	-4,2	-16,4	-34,6
Total	**-4,6**	**-1,0**	**1,4**	**4,6**	**20,3**	**20,7**

*=includes installation materials: ducts, terminal units, etc.

Task 5: BAT ventilation fan: B-wheel

- **High efficiency backward-curved ‘air foil’ centrifugal fans**



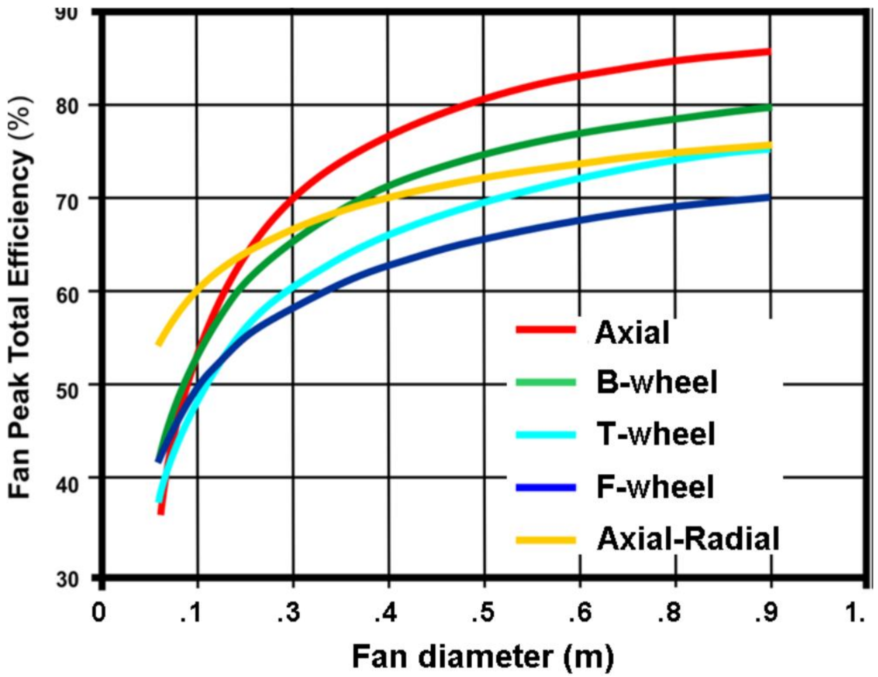
Based on AIVC TN 65

Overview

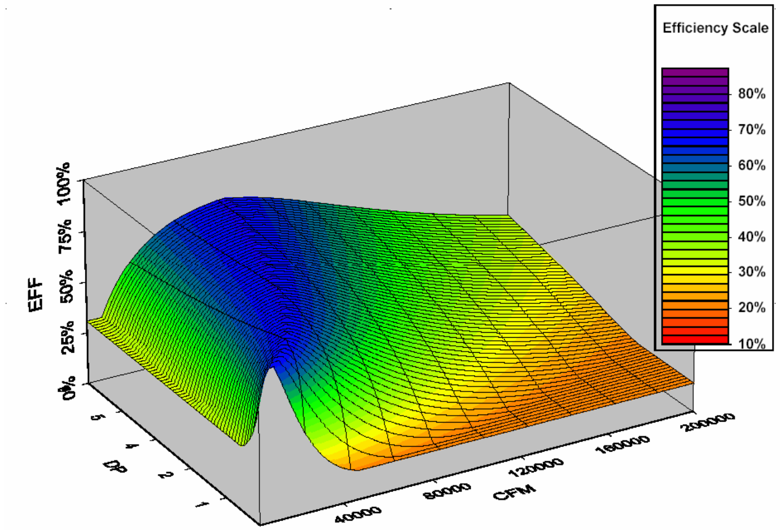
Task 5: BAT fan size and operation

Low rpm, large impeller fans

Based on AIVC TN 65



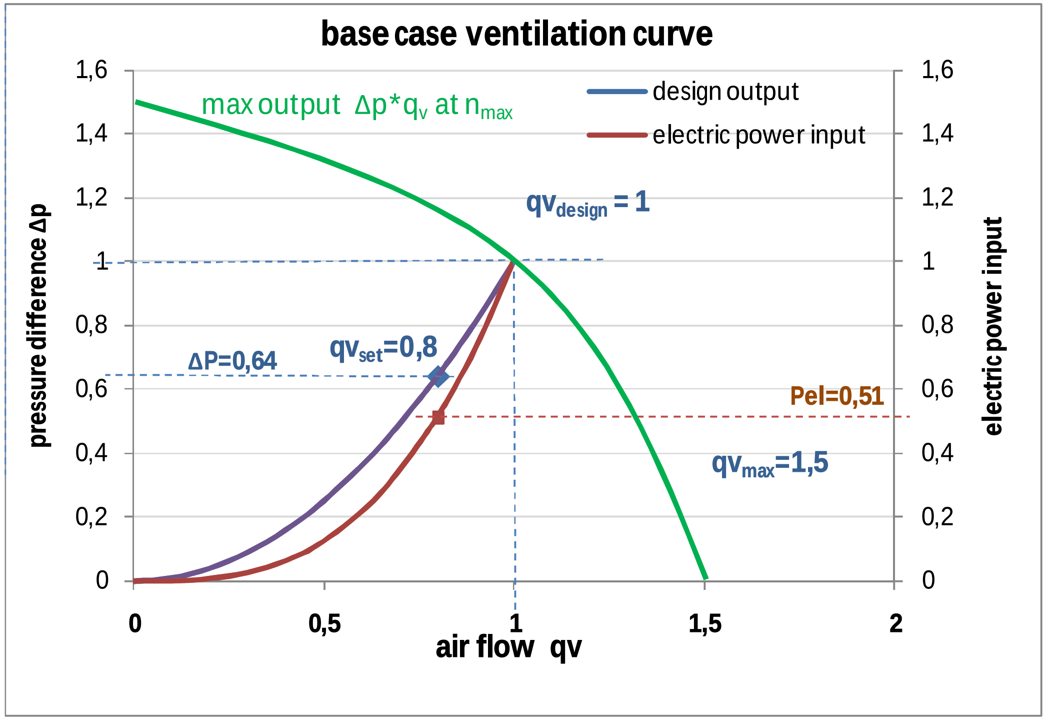
Fan peak efficiency curves. [Source: Engineering & Manufacturing Corp]



3D curve of pressure (DP), air flow (CFM) and efficiency (EFF) for a 49" housed airfoil fan (Hydeman et al.)

Task 5: BAT fan size and operation

Variable speed drives



Fan laws: **20%** decrease of the speed leads linearly to a 20% reduction in air flow, 36% in pressure difference and almost **50%** decrease $(1-0{,}8^3)$ in absorbed power.

Task 5: BAT transmission

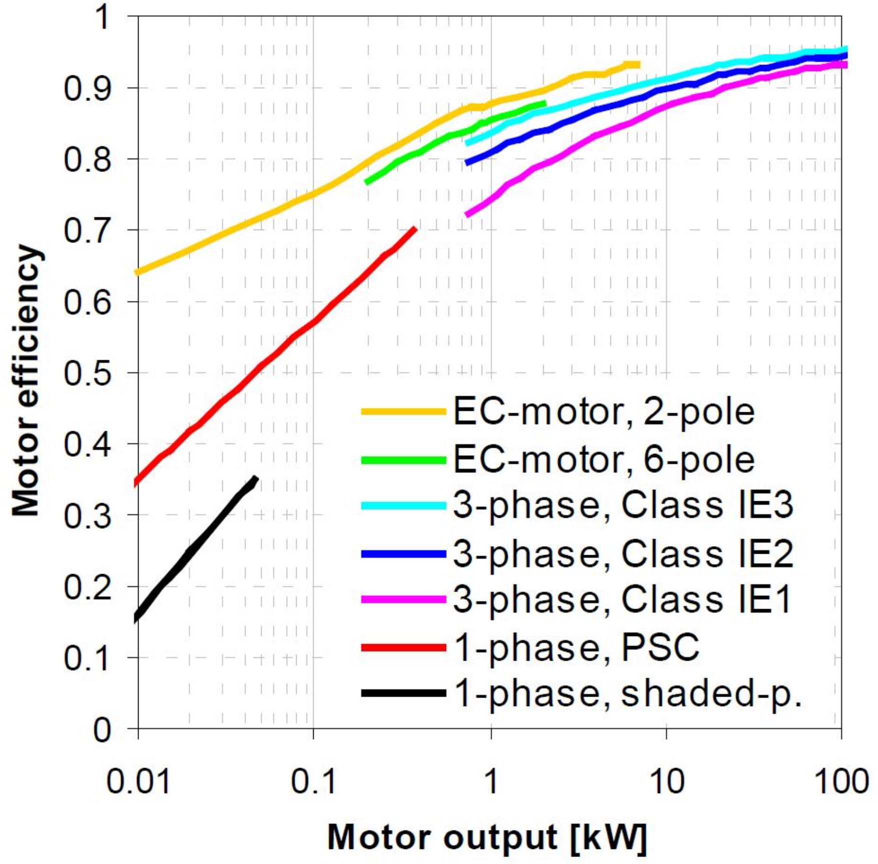
Direct transmission (no belt drive)

Table 5- 2 .Examples efficiency for specific components in central air system (EN 13799, Annex D, Table D.1)

Component	Efficiency in %		
	Low		High
Belt drive < 1.1 kW η_{Drive}	70	75	80
Belt drive < 3.0 kW η_{Drive}	75	80	85
Belt drive < 7.5 kW η_{Drive}	80	85	90
Belt drive > 7.5 kW η_{Drive}	85	90	95
Flat belt η_{Drive}	90	93	97
Direct drive	100	100	100

Task 5: BAT motor efficiency

Brushless DC/ EC (<10 kW, ‘IE4’) or ‘IE3’ level AC (> 10 kW) (95% efficient)



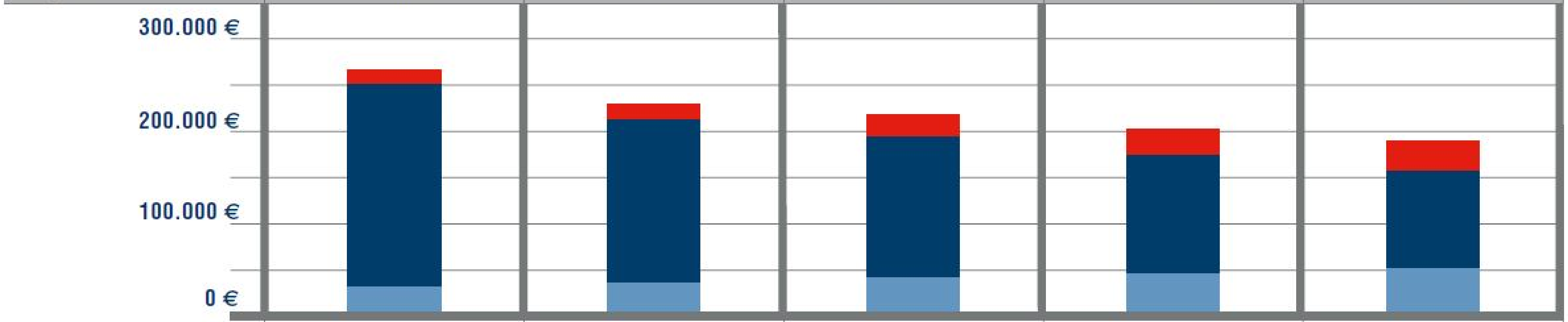
Based on AIVC TN 65

Task 5: BAT face velocity

Low face velocity (<0,5 m/s for small units ; <1,5 m/s for largest AHUs), through large filter sections, large heat recovery faces, large and aerodynamically optimal fan- and outlets;

Unit sizes:

Operating time 24 hours per day, 7 days per week:

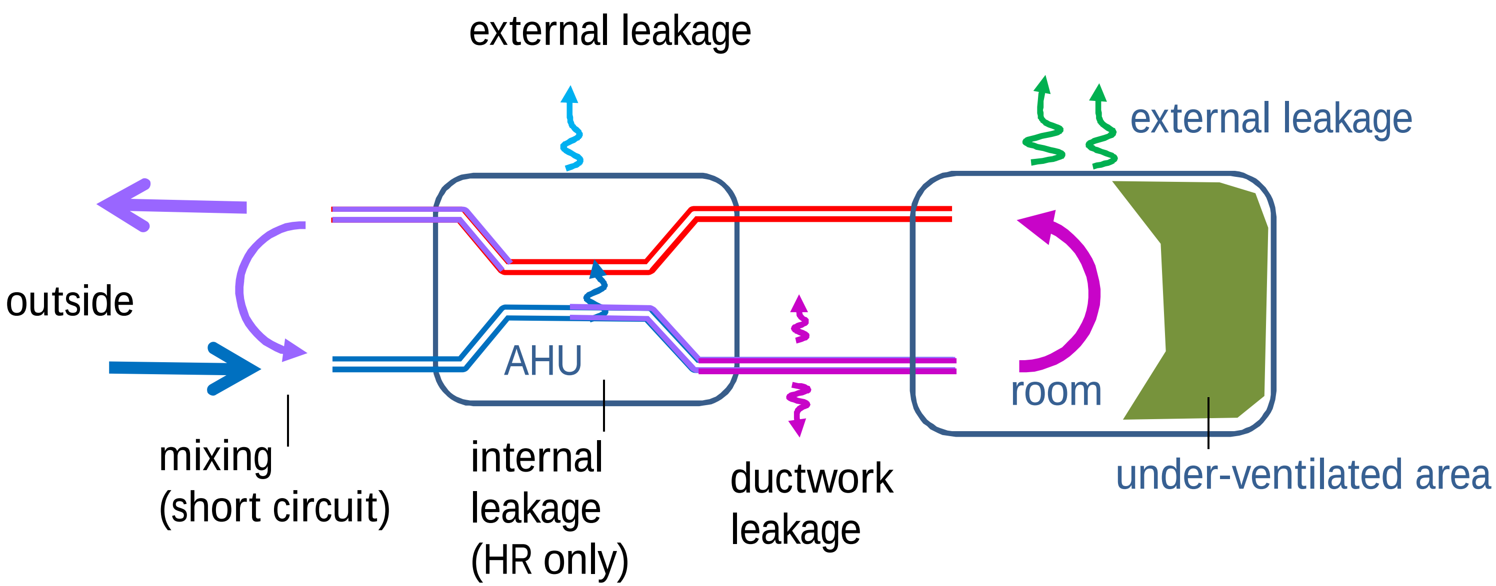


air speed	3.2 m/s	2.6 m/s	2.3 m/s	1.9 m/s	1.5 m/s
	air-handling unit 1	air-handling unit 2	air-handling unit 3	air-handling unit 4	air-handling unit 5
cost of space reorganisation	14,324 €	16,877 €	19,750 €	23,130 €	29,777 €
power costs	222,444 €	177,232 €	157,338 €	133,828 €	108,509 €
capital costs	32,862 €	39,799 €	42,155 €	45,753 €	52,242 €
sum LCC	269,630 €	233,908 €	219,242 €	202,710 €	190,528 €
initial investment costs	22,740 €	27,540 €	29,170 €	31,660 €	36,150 €

Figure 5-15. EXAMPLE: Costs and savings of lowering face velocity [source: AL-KO]

Task 5: BAT leakage rates

Low leakage rates & minimal short-circuiting



Task 5: BAT filters

Low resistance filters

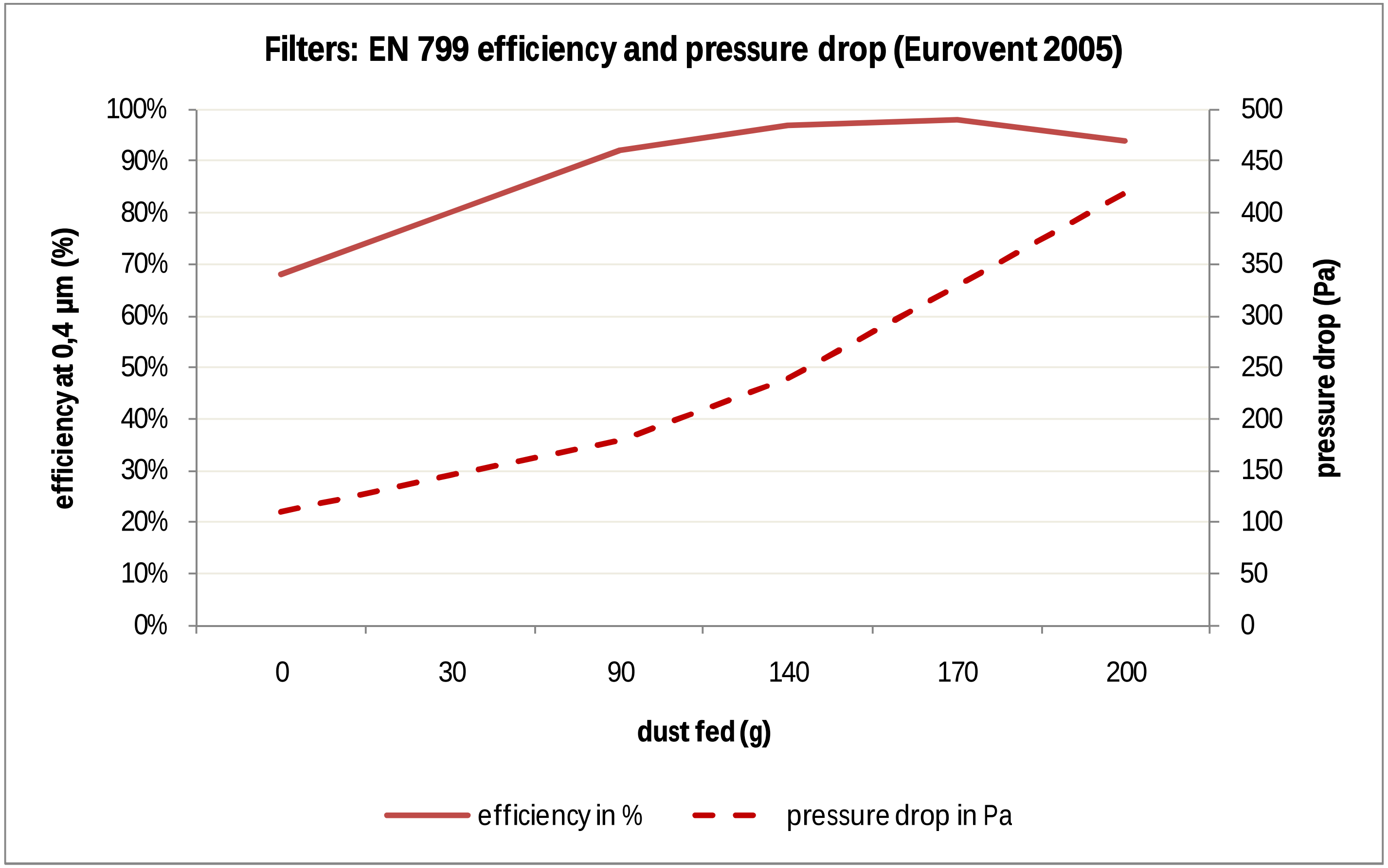
Table 5-9. Examples for filter pressure drops

Component	Pressure losses in [Pa]		
	Low		*High*
Air filter F5 – F7 per section [2)]	100	150	250
Air filter F8 – F9 per section [2)]	150	250	400
HEPA filter	400	500	700
Gas filter	100	150	250

(extract from acc. table A.8 of EN13779, copy of Task 1, Table 1-33)

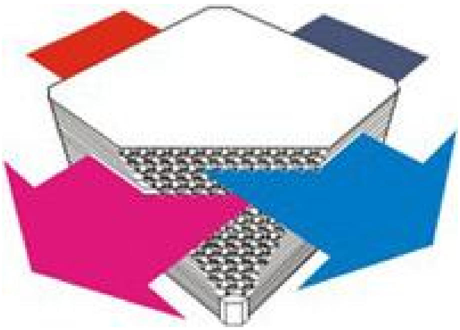
Task 5: BAT filter operation

More frequent filter change , Δp sensor or timer



Task 5: BAT heat recovery HE

High-efficiency heat recovery



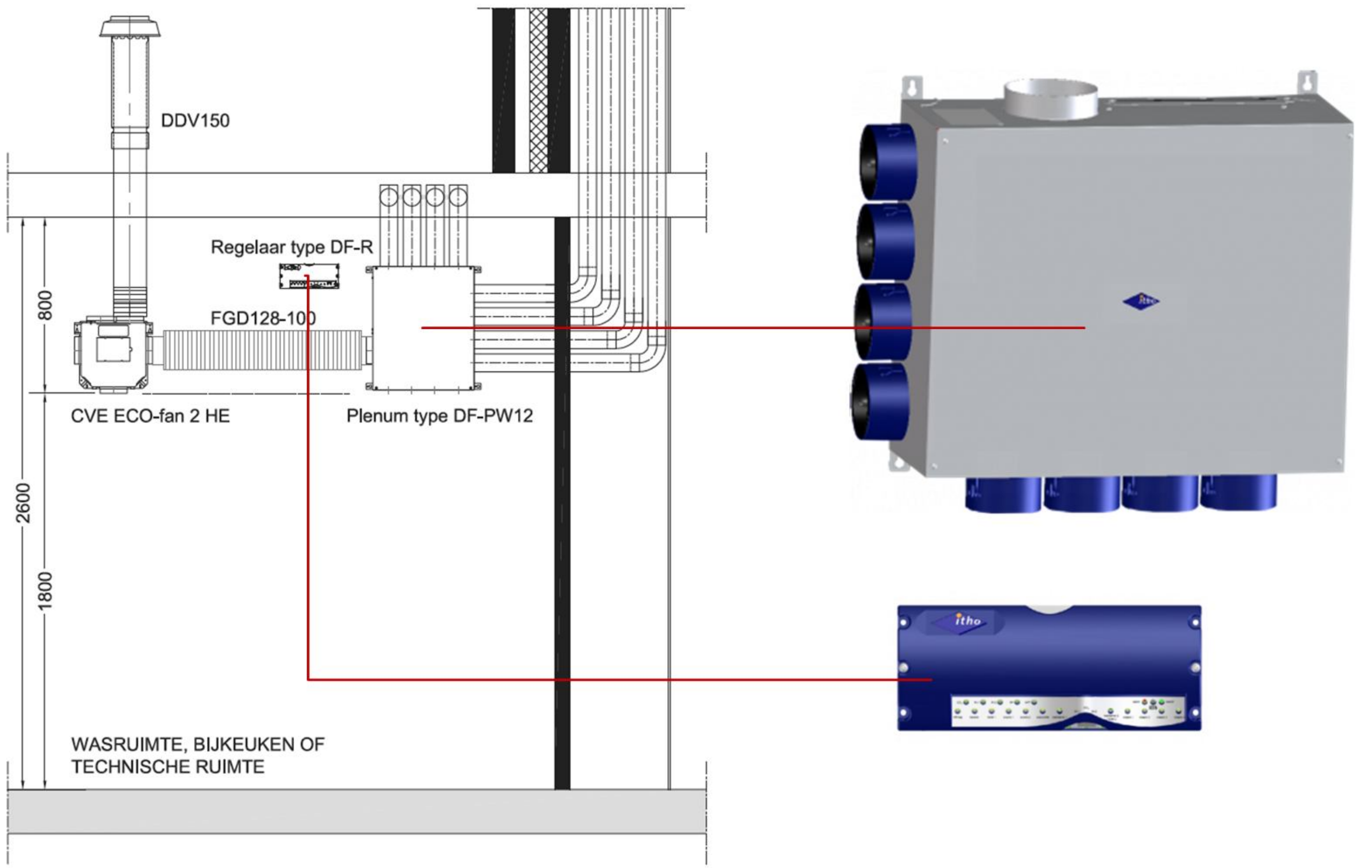
$$\eta_e = \eta_t \bullet (1 - 1 / \varepsilon)$$

Table 5- 13. Heat Recovery energy efficiency EN 13503 classes

EN 13503 Class	Energy efficiency η_e(in %)	η_t (in %)	Δp_{HRS} in Pa	ε
H1	**71**	**75**	**2 x 280**	**19,5**
H2	64	67	2 x 230	21,2
H3	55	57	2 x 170	24,2
H4	45	47	2 x 125	27,3
H5	36	37	2 x 100	26,9
H6	No requirement	n.a.	n.a.	n.a.

Task 5: BAT controls

Occupancy rate sensors per zone



Task 5: Technical: Best Available Technology

- **High efficiency backward-curved ‘air foil’ centrifugal fans**
- **Low rpm, large impeller fans**
- **Variable speed drives**
- **Direct transmission (no belt drive)**
- **Brushless DC (<10 kW) or ‘IE3’ level AC (> 10 kW) (95% efficient)**
- **Low face velocity (<0,5 m/s for small units ; <1,5 m/s for largest AHUs)**
  through large filter sections, large heat recovery faces, large and aerodynamically optimal fan- and outlets;
- **Low leakage rates & minimal short-circuiting**
- **Low resistance (electrostatic?) filters**
- **More frequent filter change , Δp sensor or timer**
- **High-efficiency heat recovery**
- **Free cooling bypass (see airco part of study)**
- **Occupancy rate sensors per zone**
- **Static Pressure Reset air-side control (if in scope)**

Overview

Also based on AIVC TN 65

Task 5: BNAT

- Larger brushless DC/EC motors up to 100 kW (currently only in electric cars
- Downsize single ventilation system, smart balance large and small units;
- More increase fan impeller diameter and decrese of fan speed;
- Smart ‘hybrid’ solutions, probably also more slow-moving axial fans;
- Minimal ductwork, optimal use of atriums, staircases, halls, double façade, full air-tight building shell, remaining ductwork with very large face sections;
- Renovation: through the wall solutions, integration with façade renewal;
- Local VSD ventilation solutions to replace local VAV-box;
- Trends to continue: Ventilation and ‘air conditioning’(space cooling and/or heating) will be more and more separate systems.
- Envisaged up to 10% energy saving over BAT

10% better than BAT

Outlook **(preliminary estimates for tasks 6 and 7)**

Today:

- electricity consumption 127 TWh/a (457 PJ primary energy) → 50 Mt CO_2
- saving on heating fuel 2065 PJ primary energy → 120 Mt CO_2 avoided
- Today's balance: ca. 1600 PJ and 70 Mt CO_2 avoided

Potential :

- Electricity at same total level (at much higher market penetration)
- Extra saving: **4000 PJ** and ca. **150-200 Mt CO_2** extra avoided.
- Improved Indoor Air Quality

Saving 25-30% on EU space heating

Thank you