



Ecodesign ENTR Lot 6: Ventilation Systems (fans > 125 W) Summary Tasks 1-3

René Kemna, VHK

Stakeholder meeting
Brussels, 30.9.2011

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



Legal disclaimer

The sole responsibility for the content of this presentation lies with the authors. It does not necessarily represent the opinion of the European Community. The European Commission is not responsible for any use that may be made of the information contained therein. The authors have prepared the information to the best of availability and knowledge but do not assume liability for material or immaterial damages from its use.

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

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

Draft reports

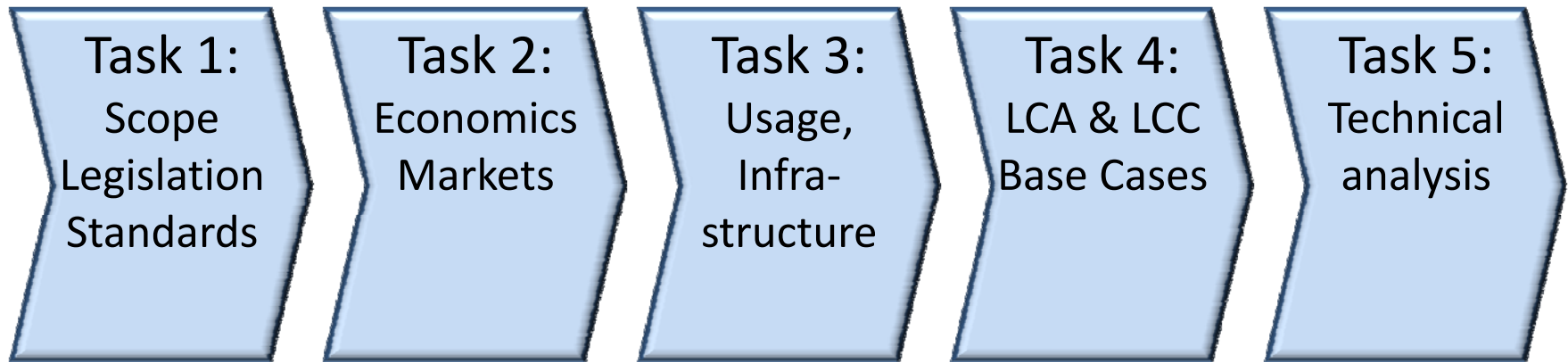
- Task 1-5 draft reports air conditioning part
- Task 1-5 draft reports ventilation system part (2.5.2011)

Written consultation

- Via feedback form on website stakeholders can deliver comments

Planning and Tasks

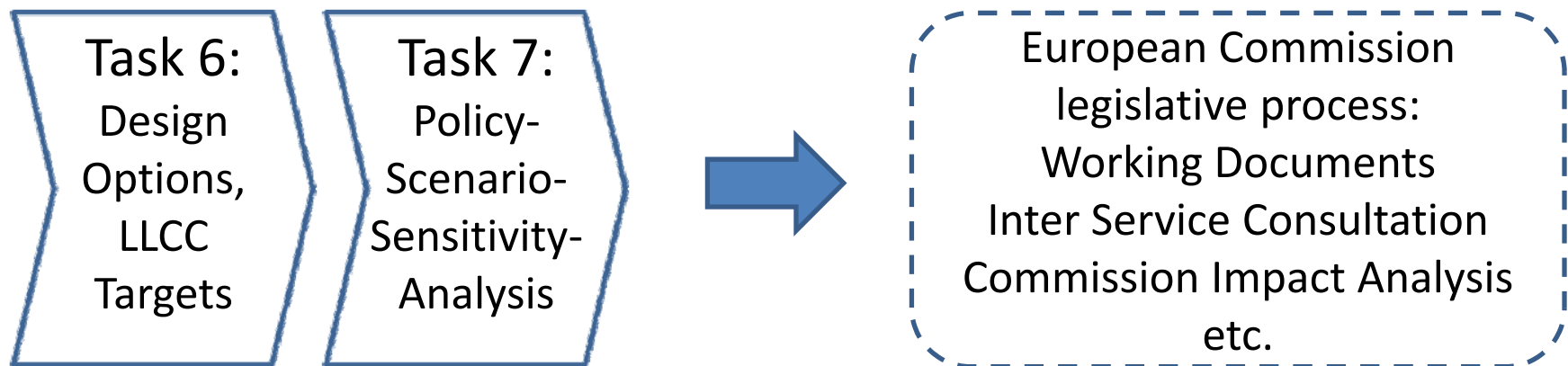
Start: Jan. 2010



May 2011



End study: Dec. 2011 (estimate)



Task 1: Product Scope Ventilation Systems

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

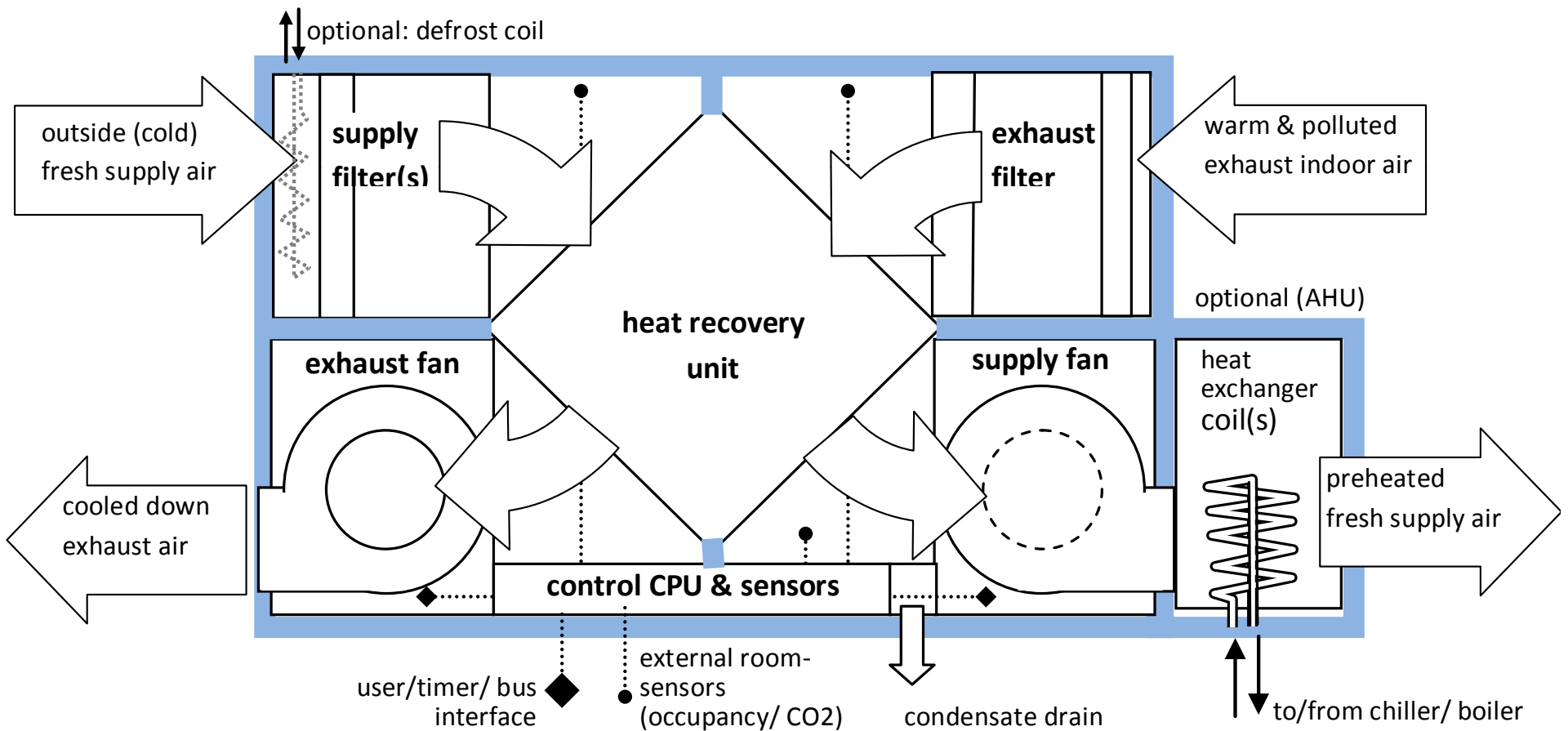
- single fan **exhaust** (or supply) units (CEXH)
- double-fan **balanced** units:
 - air handling units (AHU)
 - central **heat recovery units** (CHRV)

Included in analysis: fan(s), casing, controls, heat recovery, internal pressure drop (e.g. inlet, outlet, filter, coil)

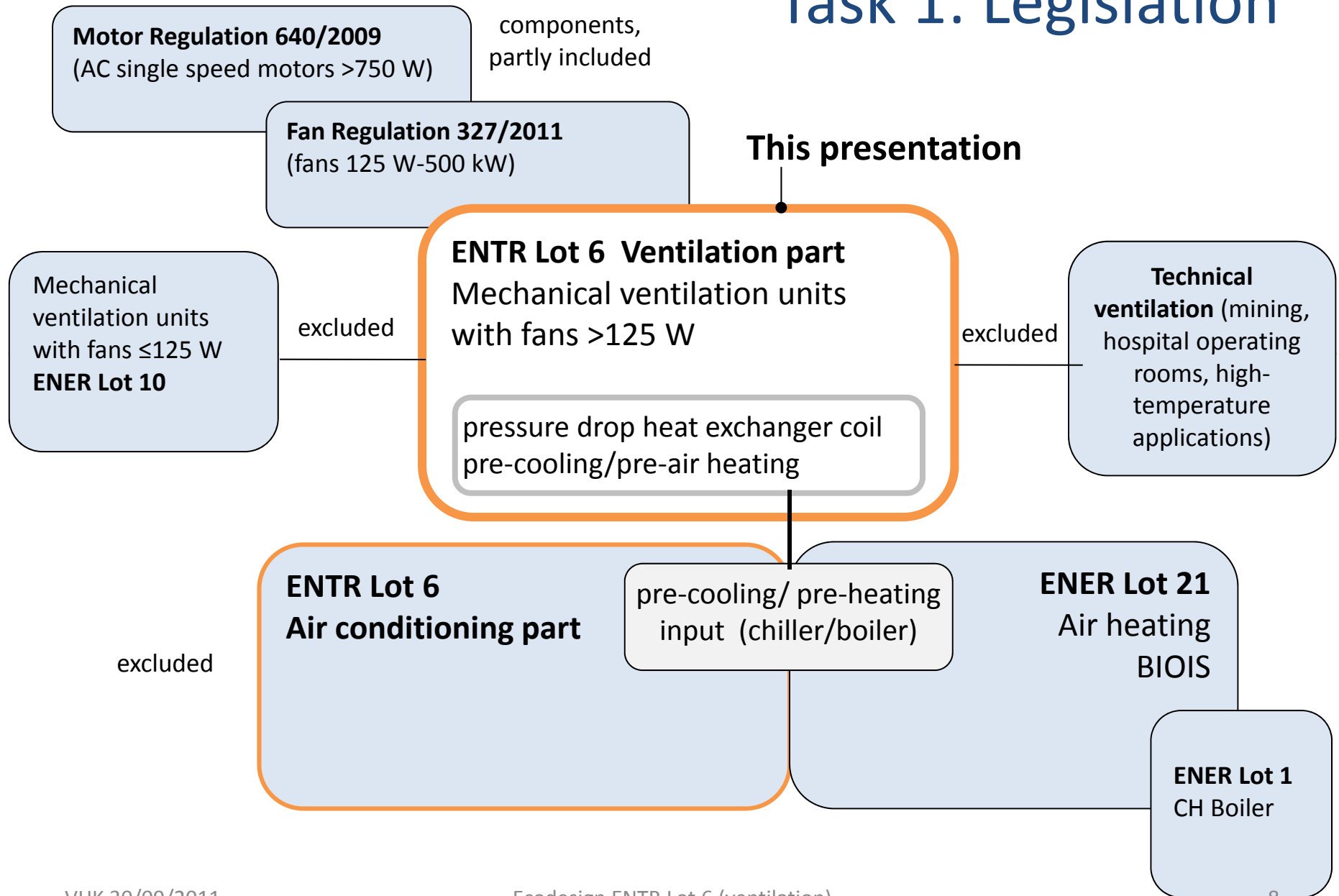
Excluded: ducts, dividers, terminal units. (de)humidifier functionality [new item]

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]

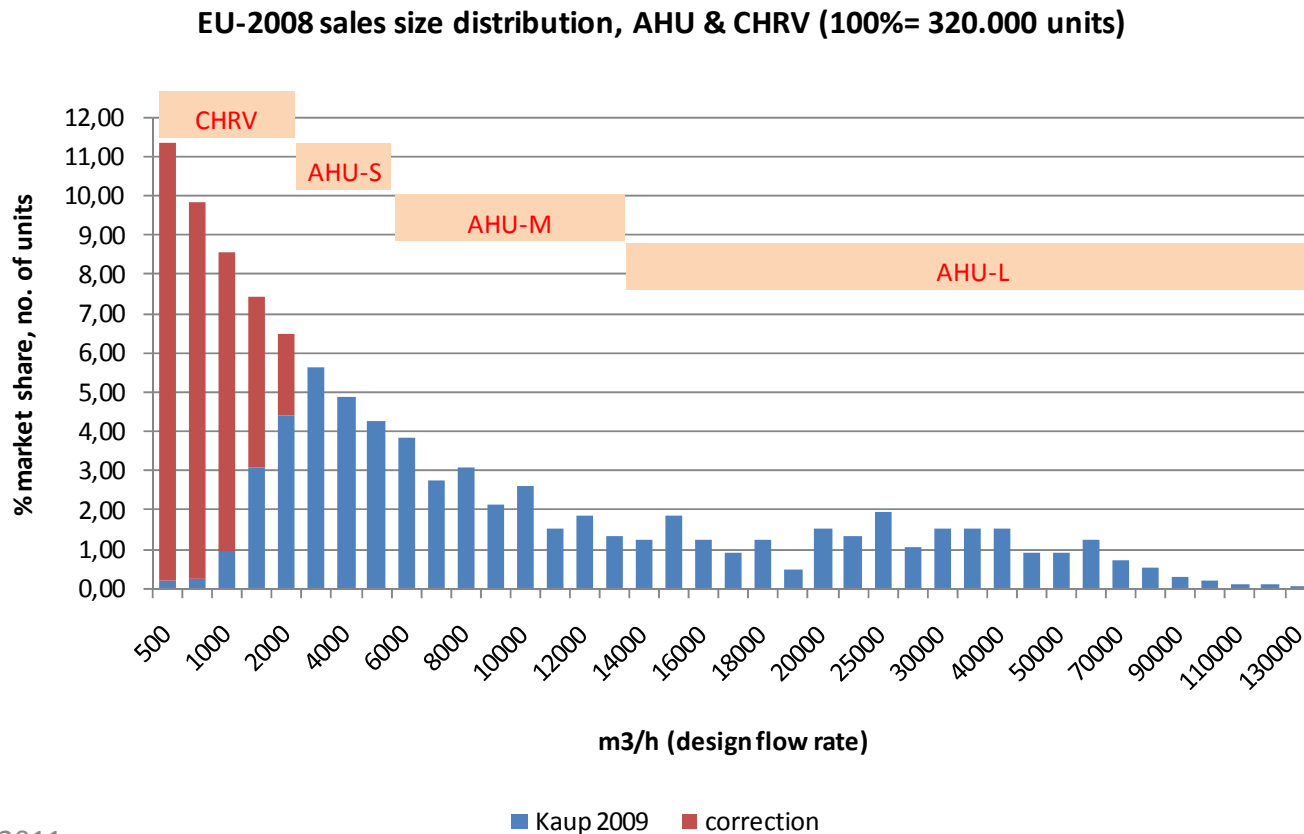
- Product scope is **both non-residential and (collective) residential** ventilation → both give relevant standards
- Residential (prEN 13142, EN 13141-x etc.) and non-residential ventilation (EN 13053, EN 13779, etc.) have **different sets of test standards** for often the same issues. They overlap 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]

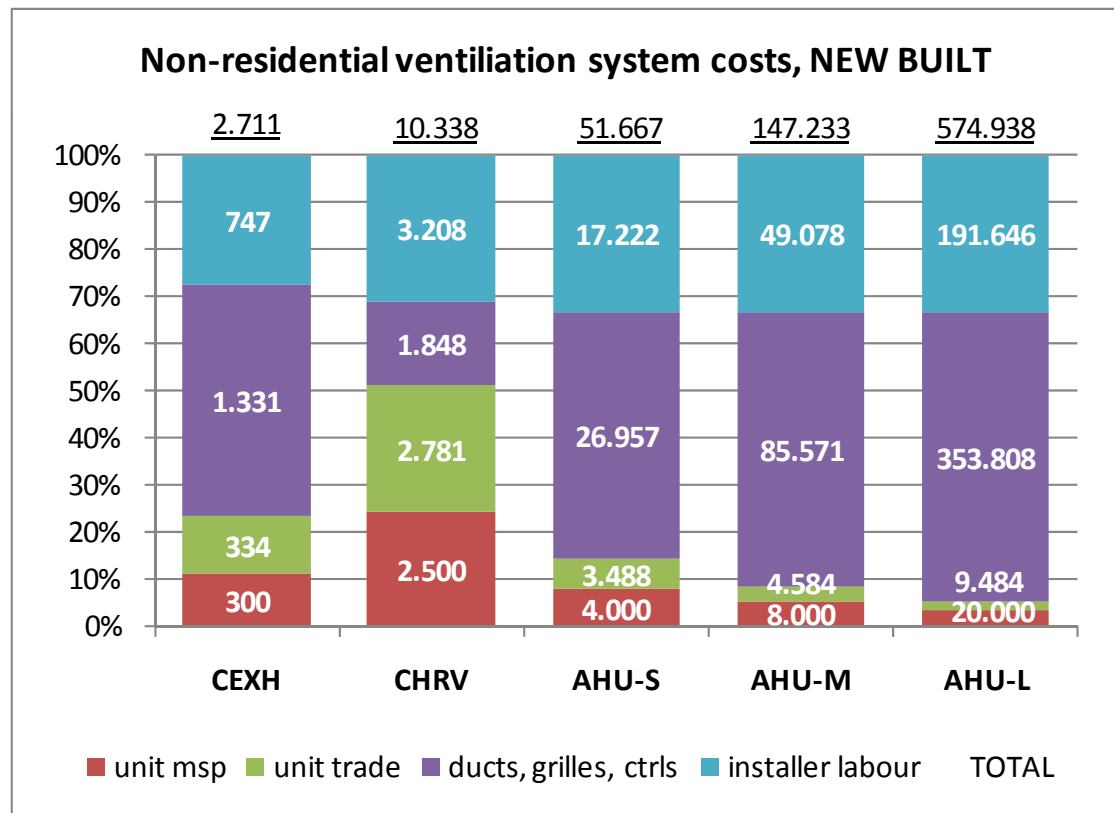
- Annual unit **EU-27 sales**: 1,1 mln. exhaust units and 0,32 mln. balanced (AHU& CHRV) units. **EU 27-stock**: 19 mln. units total.



Task 2: Economics & Markets [2]

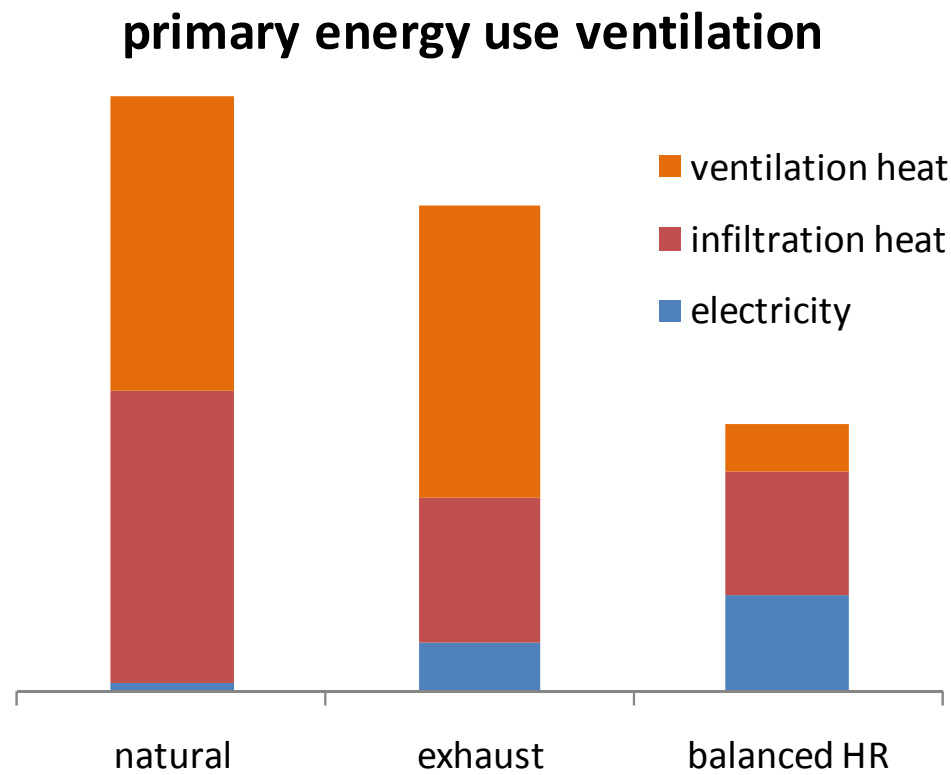
- EU-27 industry revenue on ventilation units: € 2,7 bln./a
- EU-27 revenue on related installation products and services: > € 37 bln./a.
- Ex-EU imports ca. 15%
- Ex-EU exports ca. 15%

Strong EU sector



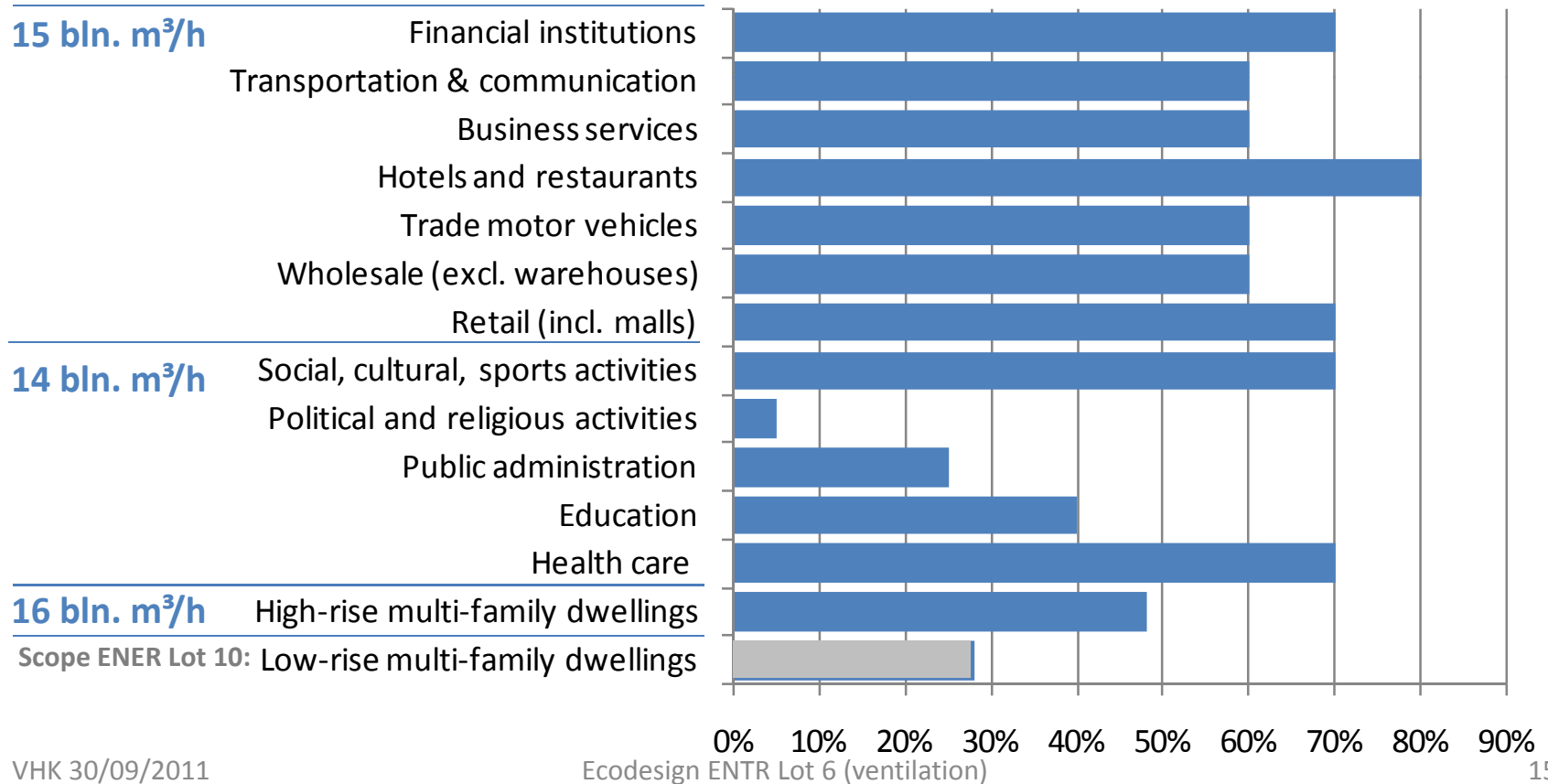
Task 3: Usage, Key Message

- 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

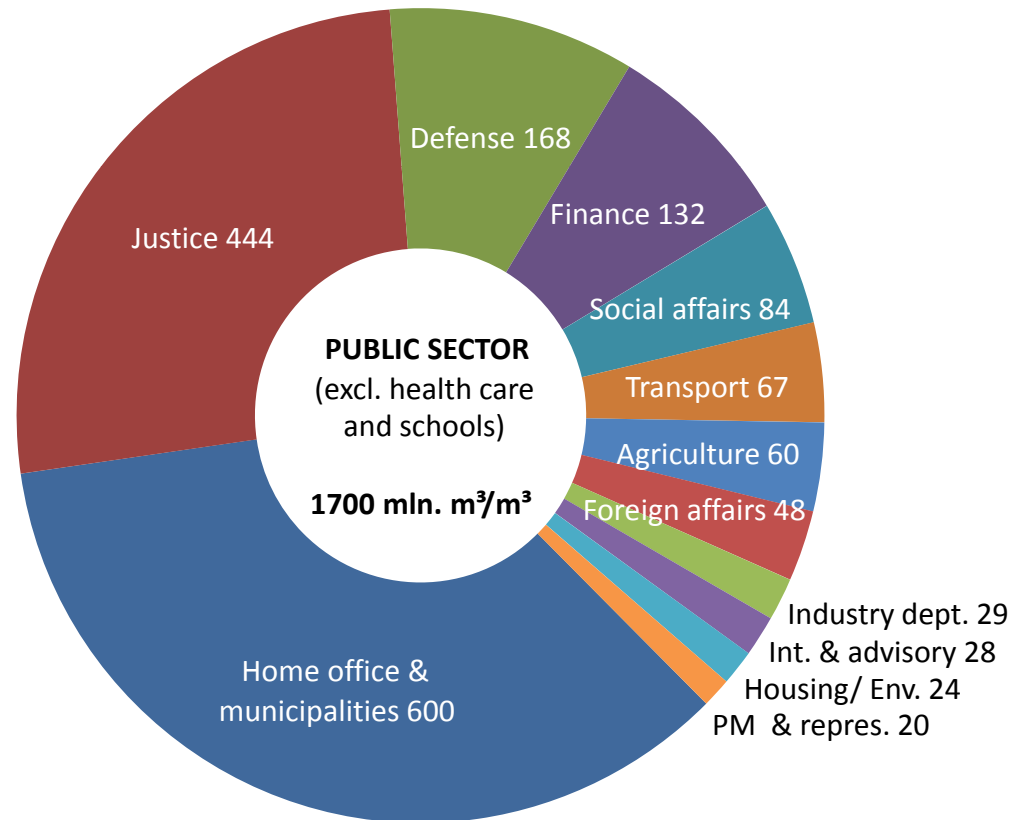
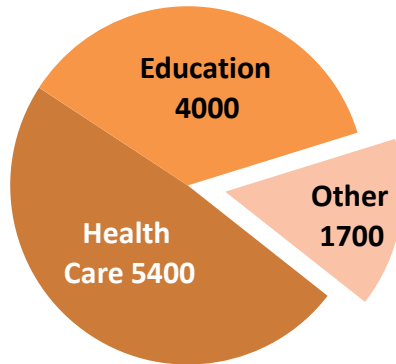
- Total 68 bln. m³/h ventilation demand in scope, in EU-27 (incl. industry 23)
- Large growth potential mechanical ventilation (figure %=penetration rate)



Task 3: Potential Efficient Ventilation

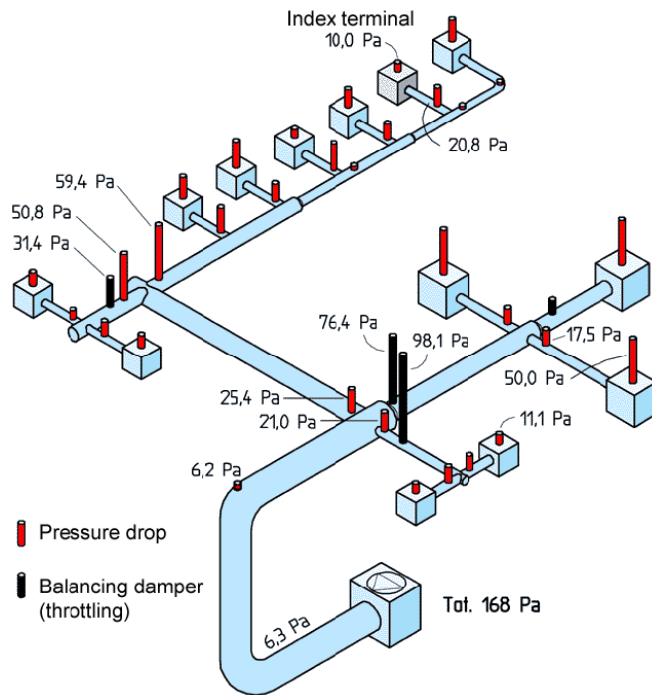
- **Balanced heat recovery ventilation still only 7% of total (5 bln. m³/h)**
- **Public sector buildings largest potential for efficient mech. ventilation**

**Public sector, health care & education:
ventilation in m³/m³.h**

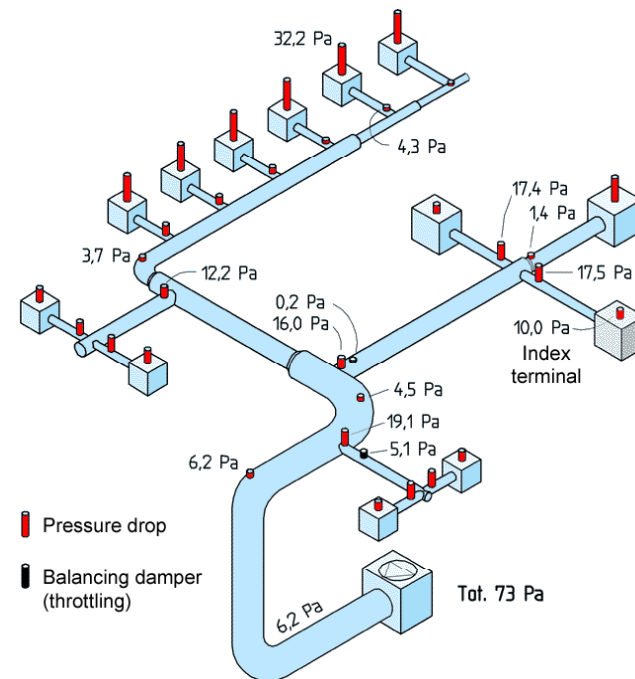


Task 3: Infra-structure

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



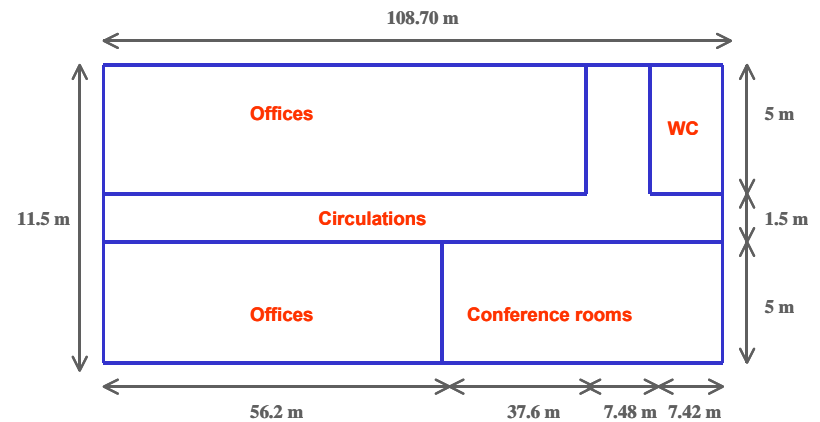
Poor design pressure drop **168 Pa**
 (source: SINTEF)



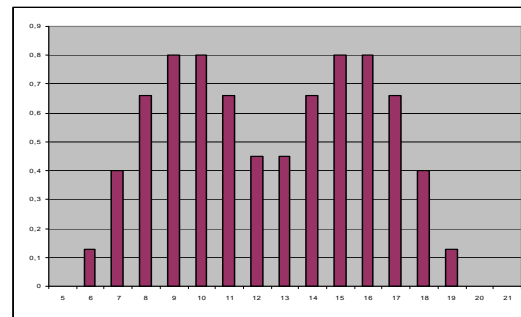
Good design pressure drop **73 Pa**
 (source: SINTEF)

Task 3: Occupancy: Case Studies

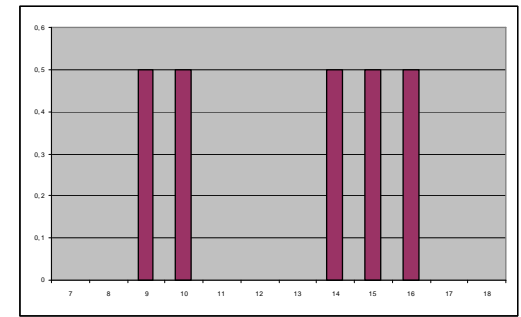
- Large office buildings (type 1)
- Medium-sized office building (type 2)
- Small office building (type 3)
- Hospital
- Retirement home
- Hotel
- Shopping mall
- Hypermarket



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%

Comments? Questions?



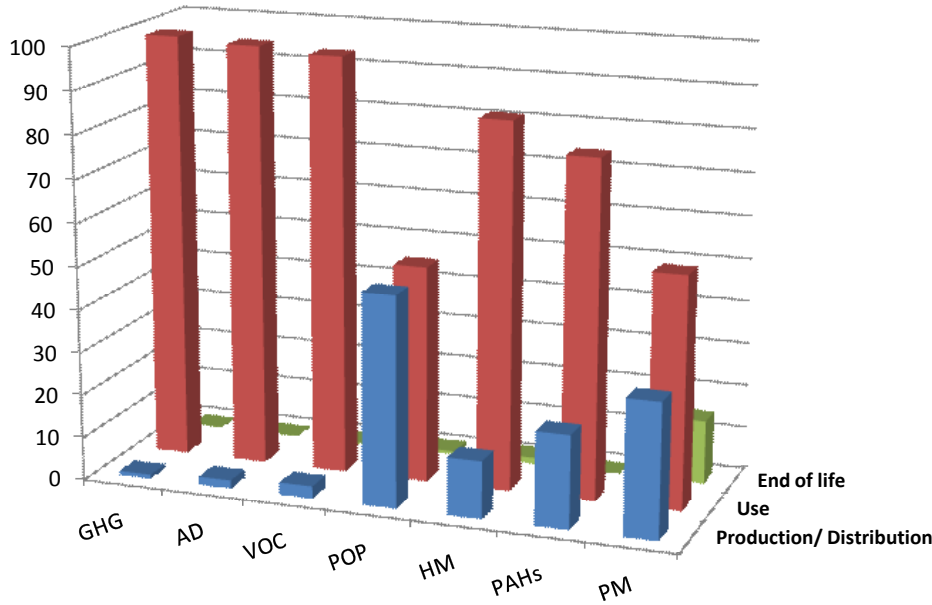
**Ecodesign ENTR Lot 6:
Ventilation Systems (fans > 125 W)
Summary Tasks 4: Definition Base Cases**

Stakeholder meeting
Brussels, 30.9.2011

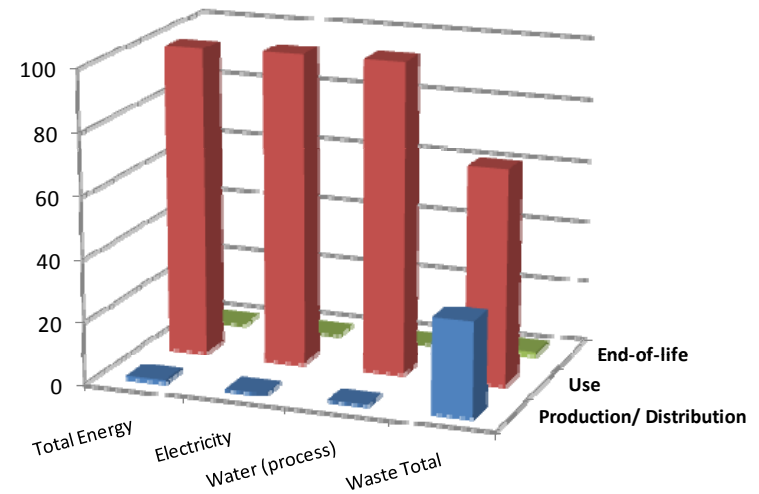
Task 4: Life Cycle Assessment (environmental)

- Use phase dominant

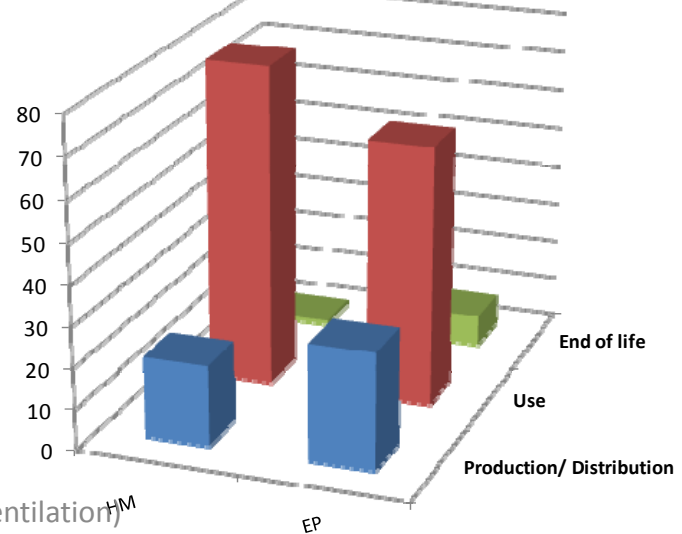
Emissions to Air



Resources & Waste



Emissions to Water

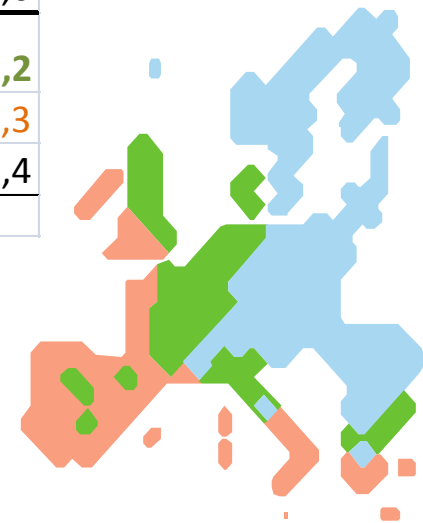


Task 4: Unit Running Costs 2010

(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.

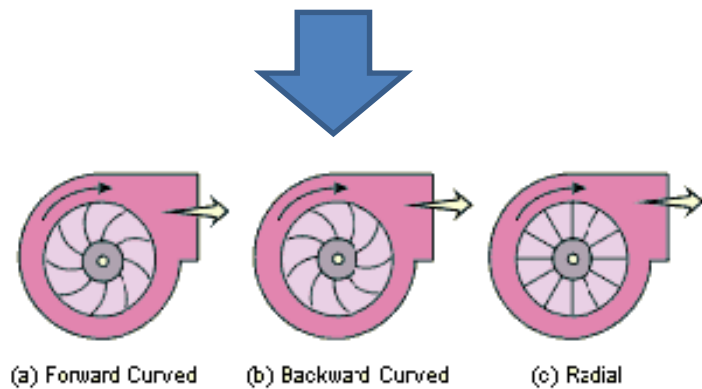


**Ecodesign ENTR Lot 6:
Ventilation Systems (fans > 125 W)
Summary Task 5: BAT & BNAT**

Stakeholder meeting
Brussels, 30.9.2011

Task 5: BAT ventilation fan: B-wheel

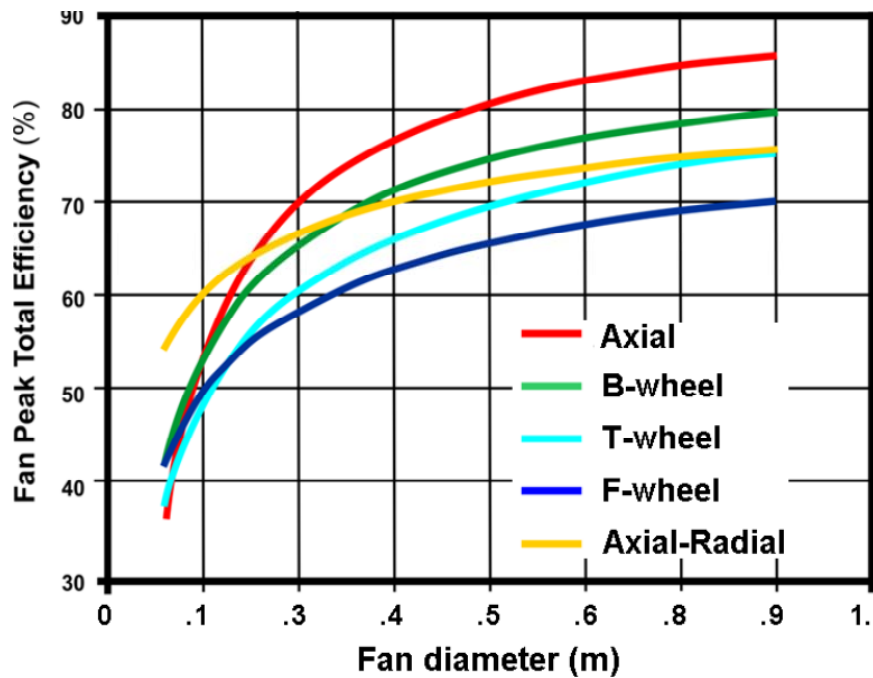
- High efficiency backward-curved 'air foil' centrifugal fans



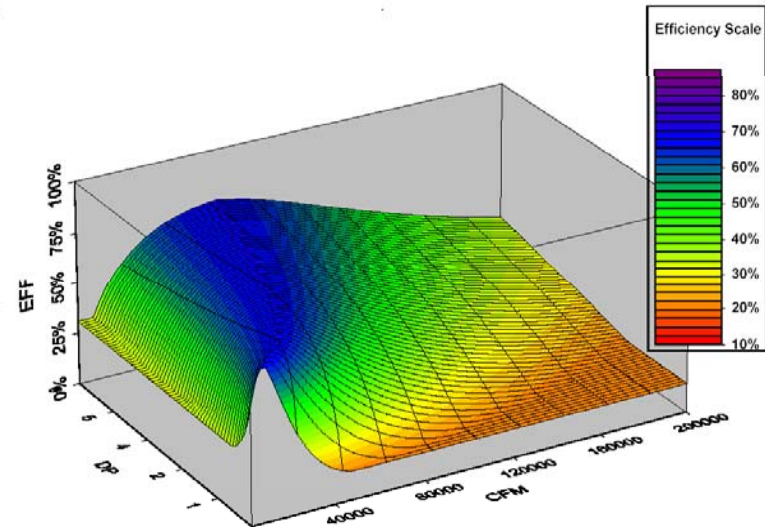
Overview

Task 5: BAT fan size and operation

Low rpm, large impeller fans



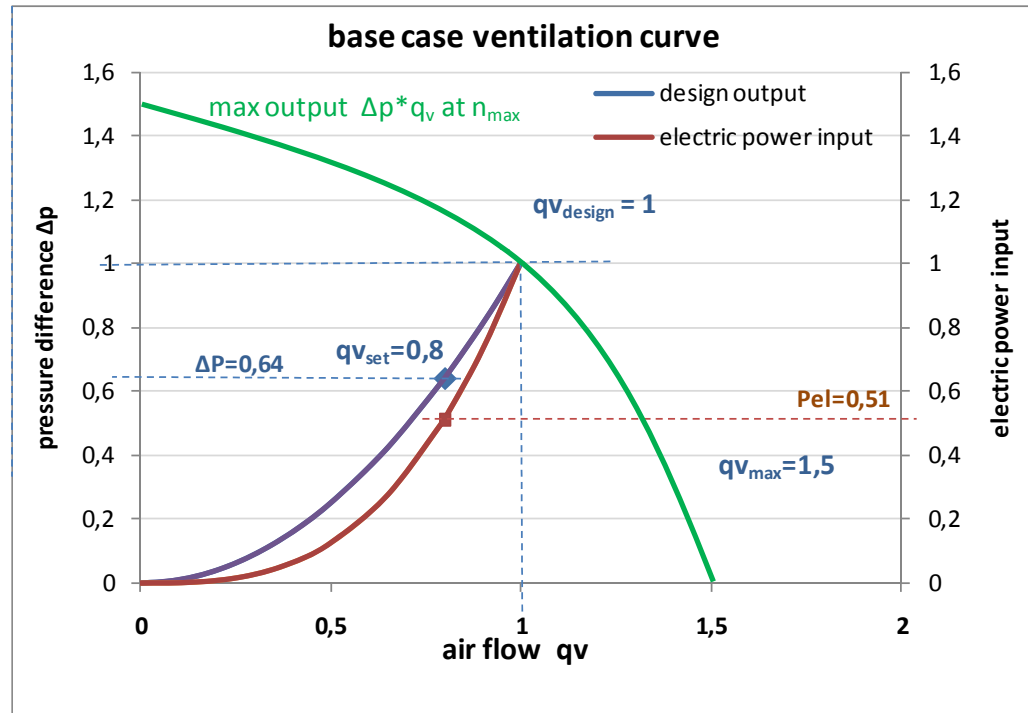
Fan peak efficiency curves. [Source: Engineering & Manufacturing Corp]



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

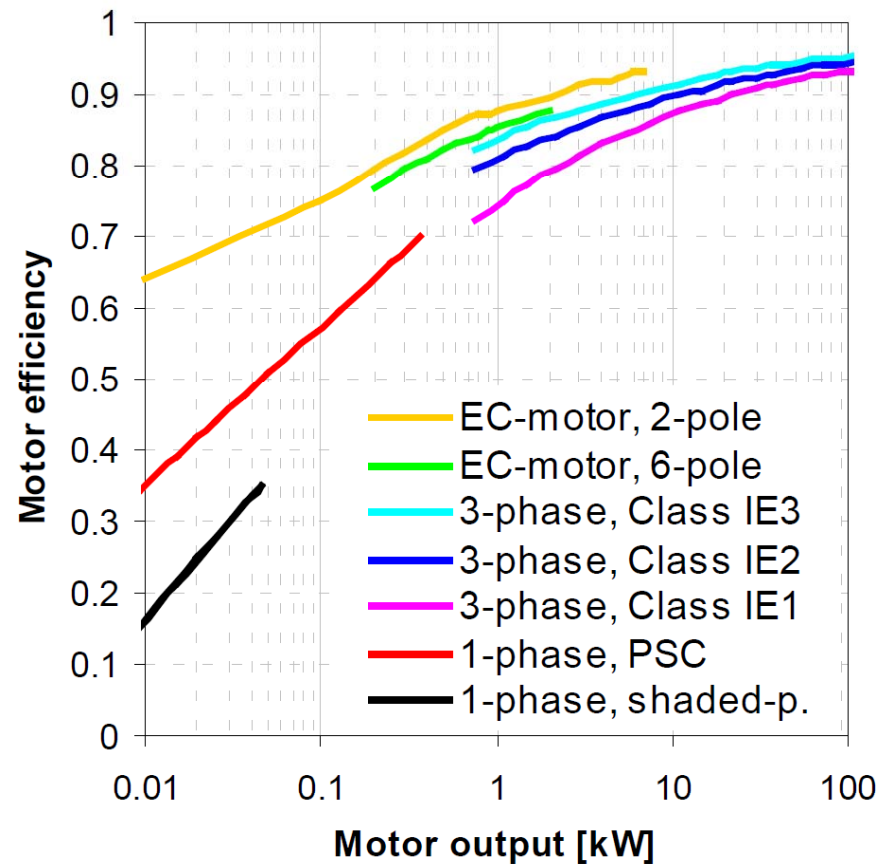
Direct transmission (no belt drive)

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)



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:

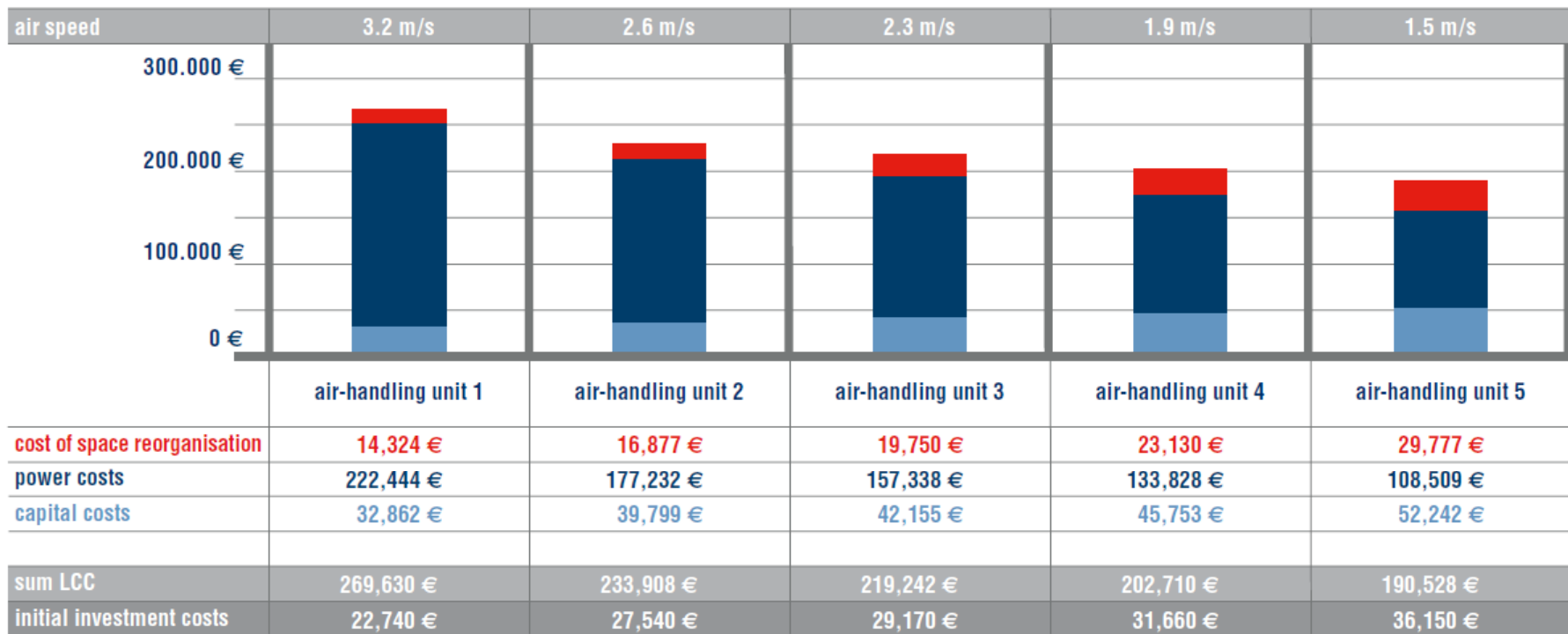
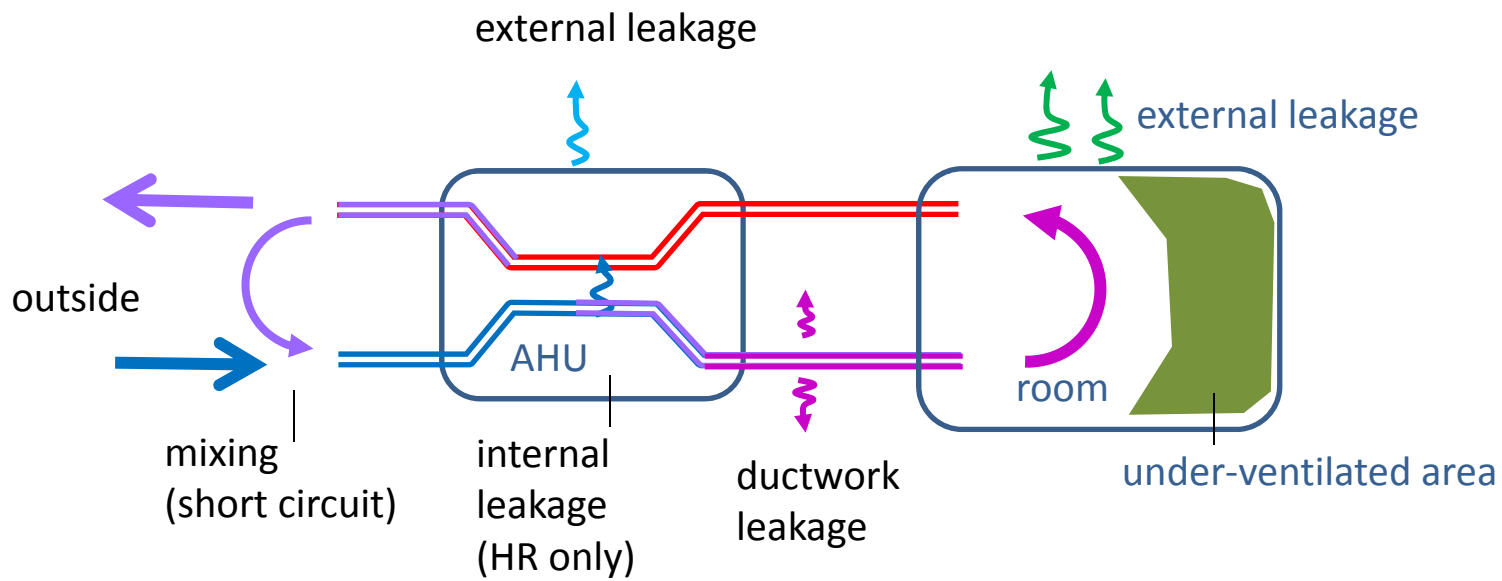


Figure 5-15. EXAMPLE: Costs and savings of lowering face velocity [source: AL-KO]

Task 5: BAT leakage rates

Low leakage rates & minimal short-circuiting



Task 5: BAT filters

Low resistance filters

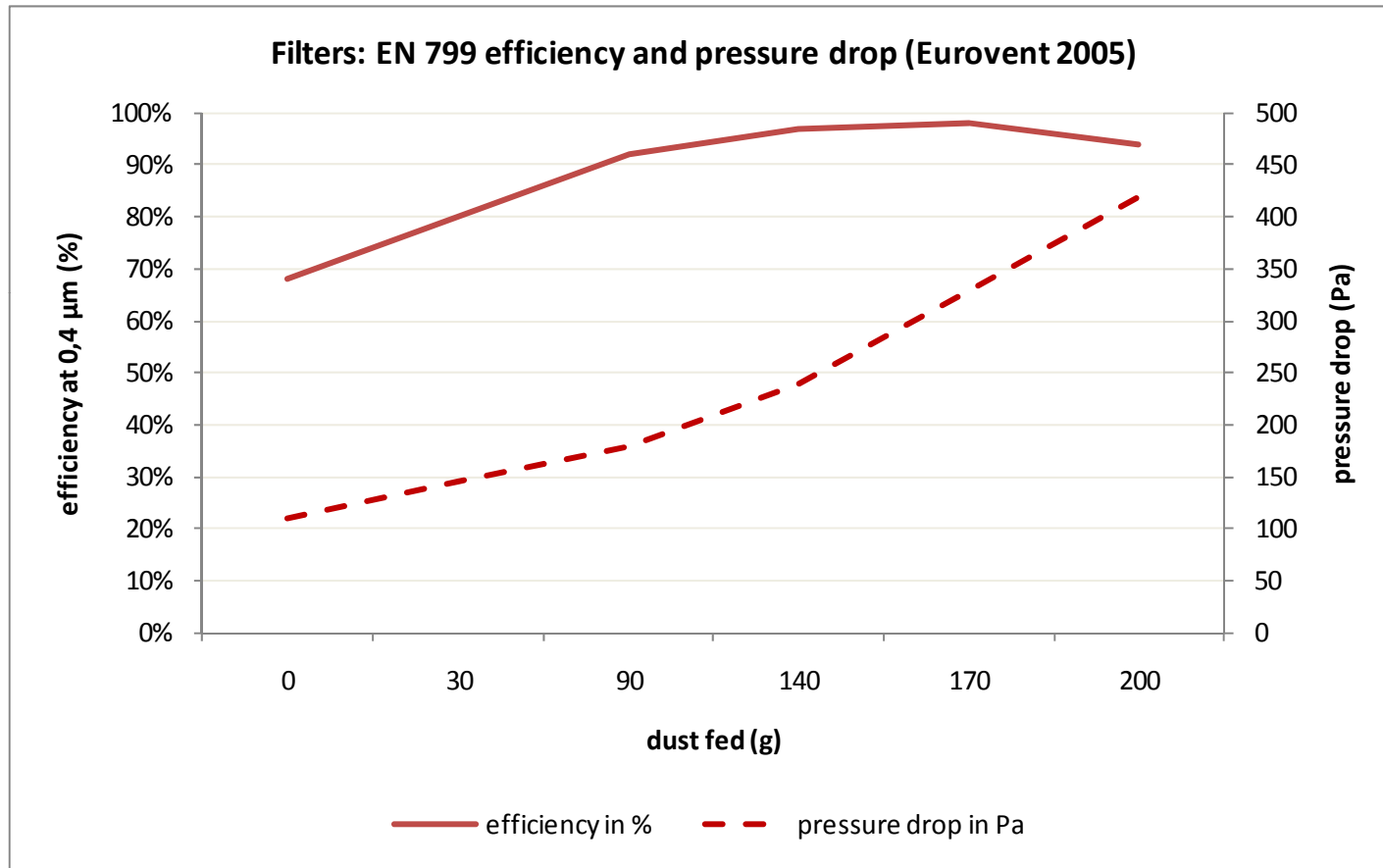
Table 5-9. Examples for filter pressure drops

Component	Pressure losses in [Pa]		
	<i>Low</i>		<i>High</i>
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



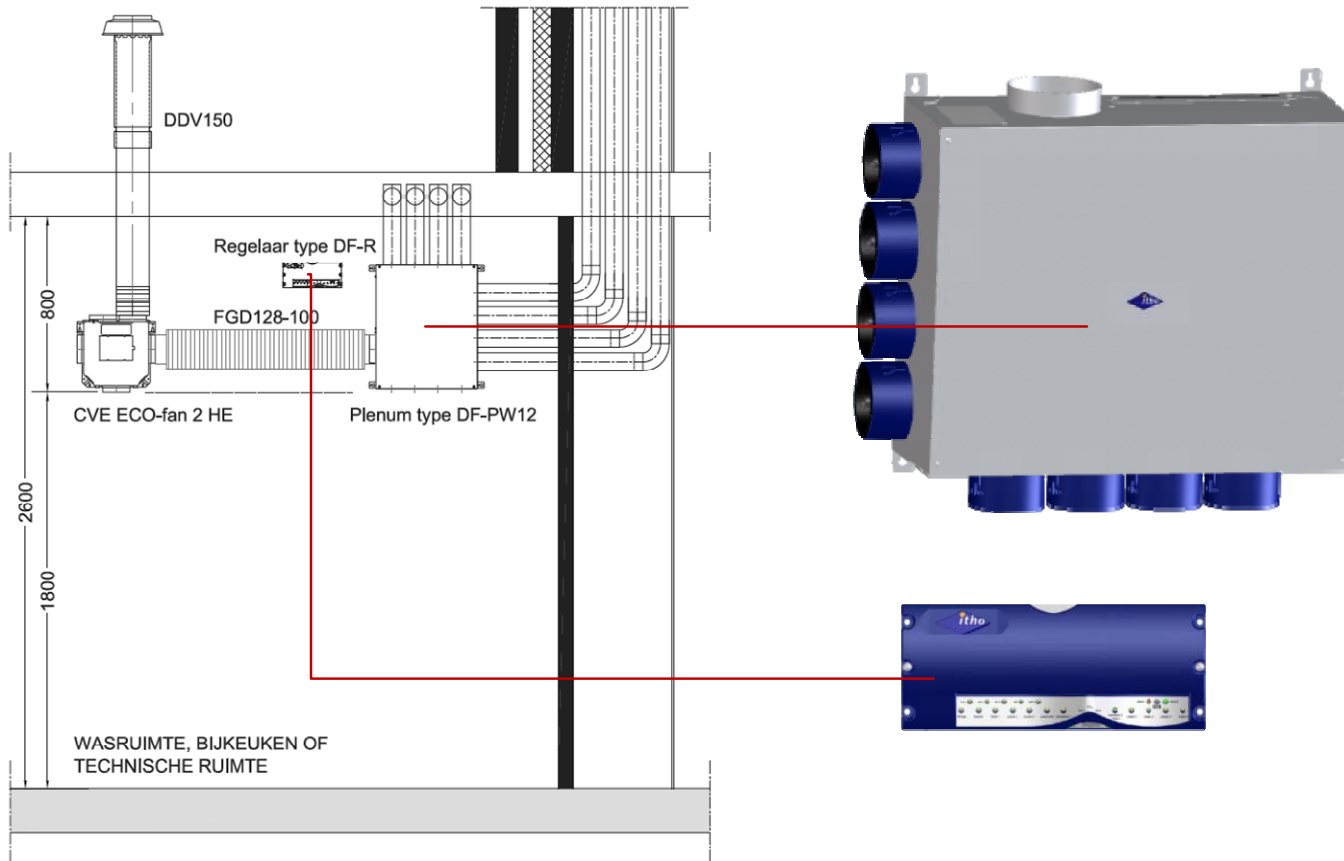
$$\eta_e = \eta_t \cdot (1 - 1 / \varepsilon)$$

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

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 decrease 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 CO₂
- saving on heating fuel 2065 PJ primary energy → 120 Mt CO₂ avoided
- Today's balance: ca. 1600 PJ and 70 Mt CO₂ avoided

Potential :

- Electricity at same total level (at much higher market penetration)
- Extra saving: **4000 PJ** and ca. **150-200 Mt CO₂** extra avoided.
- Improved Indoor Air Quality

Saving 25-30% on EU space heating

Comments? Questions?