Indoor air quality and energy efficiency

Recent developments in the EU and in the Member States

(based mainly on the HealthVent project)

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Indoor Air Quality and Thermal Comfort
Conserving Energy, Maintaining Health

BUILDING INDOOR ENVIRONMENTAL QUALITY AND VENTILATION IS SPECIFIED

in European standard EN 15251:2007 under revision in 2013

Ventilation rates should be based on pollution load from occupants and materials EN 15251:2007

$$q_{tot} = n \times q_p + A \times q_B$$

(n=number of occupants, A = floor area)

q_p *is*

Cat I: 10 l/s,pers Cat II: 7 l/s,pers Cat III: 4 l/s,pers

q_B *is for*

	Low polluting building	Non low-polluting building
Category I:	**1,0 l/s, m²**	**2,0 l/s, m²**
Category II:	**0,7 l/s, m²**	**1,4 l/s, m²**
Category III:	**0,4 l/s, m²**	**0,8 l/s, m²**

Health endpoints and Ventilation levels – Summary of literature from HealthVent WP 4

HEALTH ENDPOINT	HOME	OFFICE	SCHOOL
Asthma and allergic symptoms	0,37 - 0,32 ach (correspond to 7 L/s x p)	-	-
Respiratory symptoms	-	-	-
Airborne infectious diseases	No quantitative, health-based guideline values or thresholds can be recommended for acceptable levels of contamination by microorganisms. Association between a weekly average CO2 differential concentration greater than approximately 100 ppm and the probability of detecting airborne rhinovirus (Office)		
SBS symptoms	> 0,4 ACH protect (> 8 L/s x p)	> 9 L/s x p (< 20% of prevalence of SBS symptoms)	From 7 L/s x p to 10 L/s x p no change on SBS symptoms but increased perceived air quality
Annual sick leave	-	> 12 L/s-person reduction annual sick leave (1.2-1.9 days per person per year) .	- Every 4 L/s x p corresponds to 10-20% change in school absence rates (1 L/s x p ~ 2.5-5%)
Performance	-	≥ 15 L/s x p are likely to reduce potentially negative effects on performance	≥ 5 L/s x p are likely to reduce potentially negative effects on performance
	> 8 L/s x p	> 9 L/s x p	> 8 L/s x p

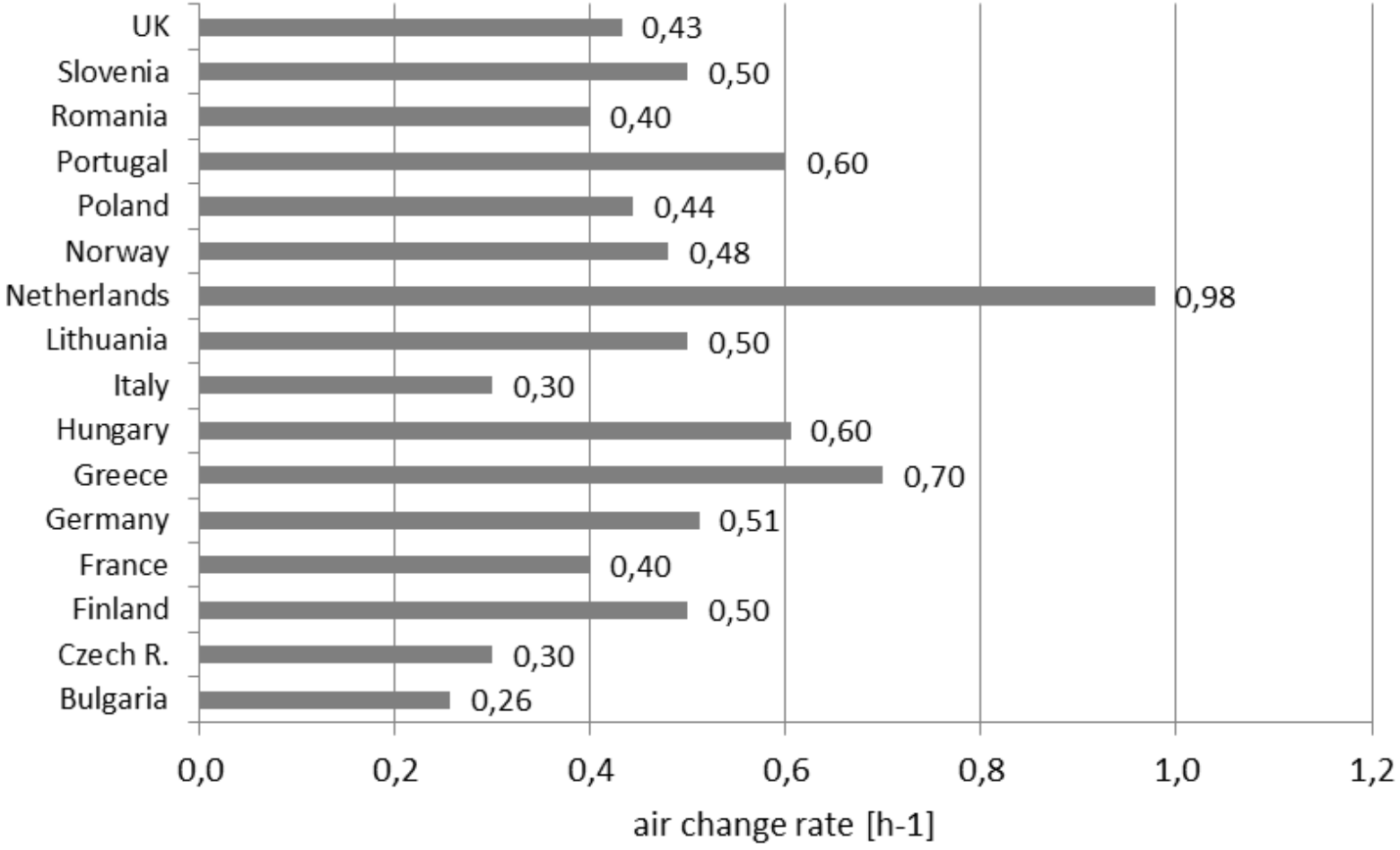
Carrer, P et al. Review of the scientific literature on the effects of ventilation on health within HealthVent project , Healthy Buildings Conference 2012

Ventilation rates in national guidelines

- **Inconsistent values (the variation is up to 1:6)**
- **Different methods to express and calculate ventilation are used (1/h per room or per apart, l/s/room, l/s/pers)**
- **Average values are close to 10 l/s/p and 0.5 ach for residences**

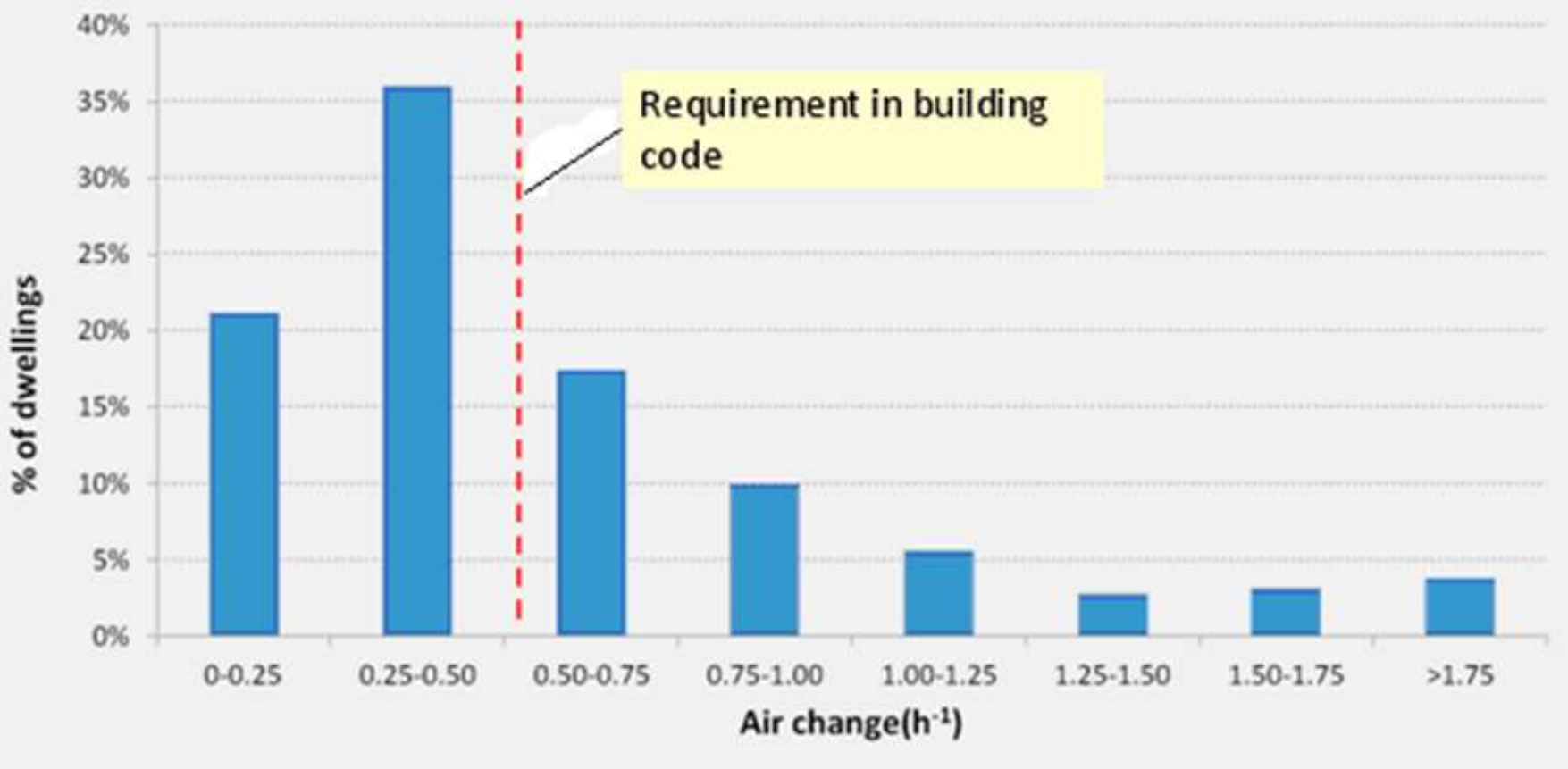
National ventilation requirement in a reference dwelling of 90 m2

(HealthVent project WP 5)

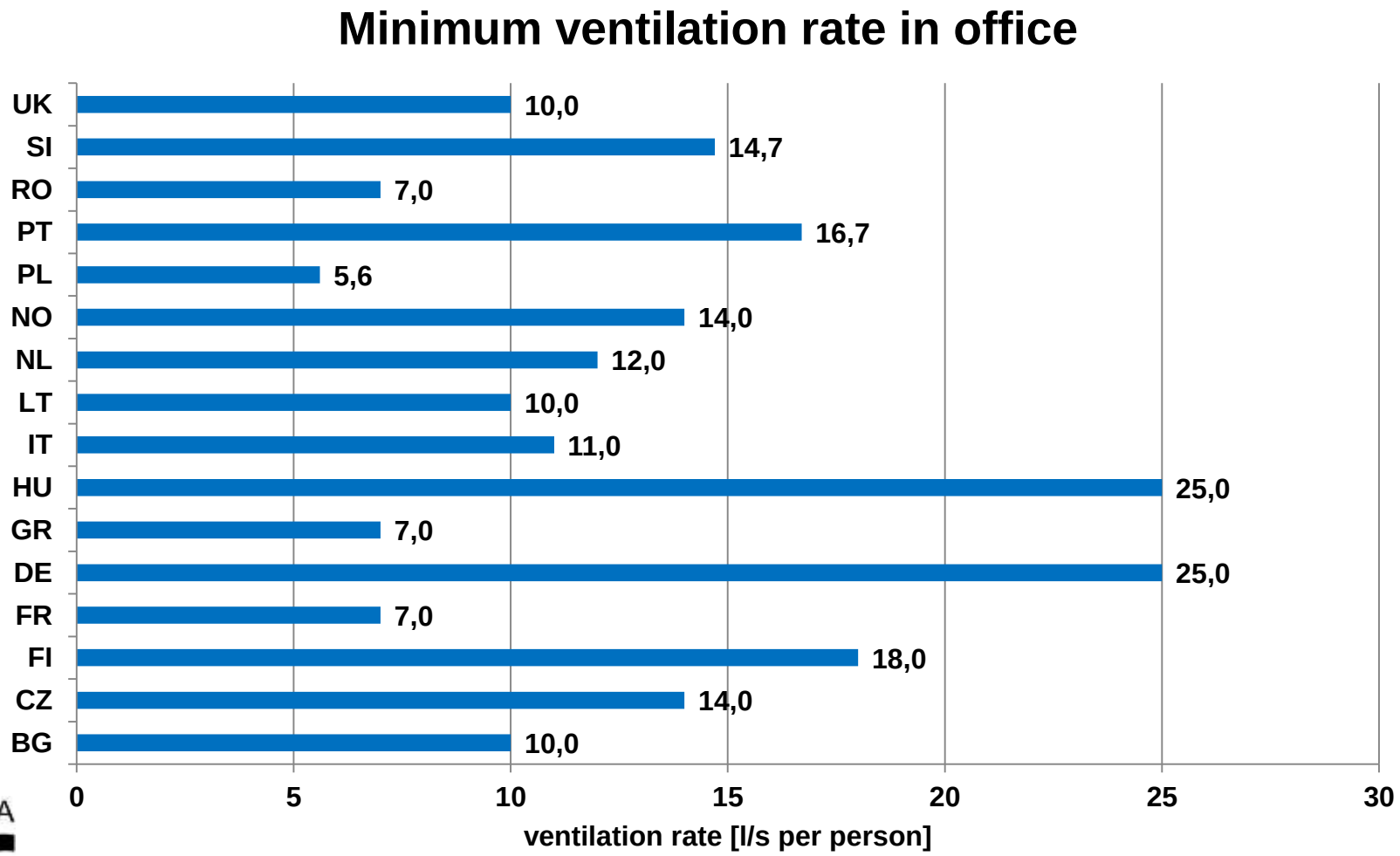


Ventilation rate in 500 Danish homes

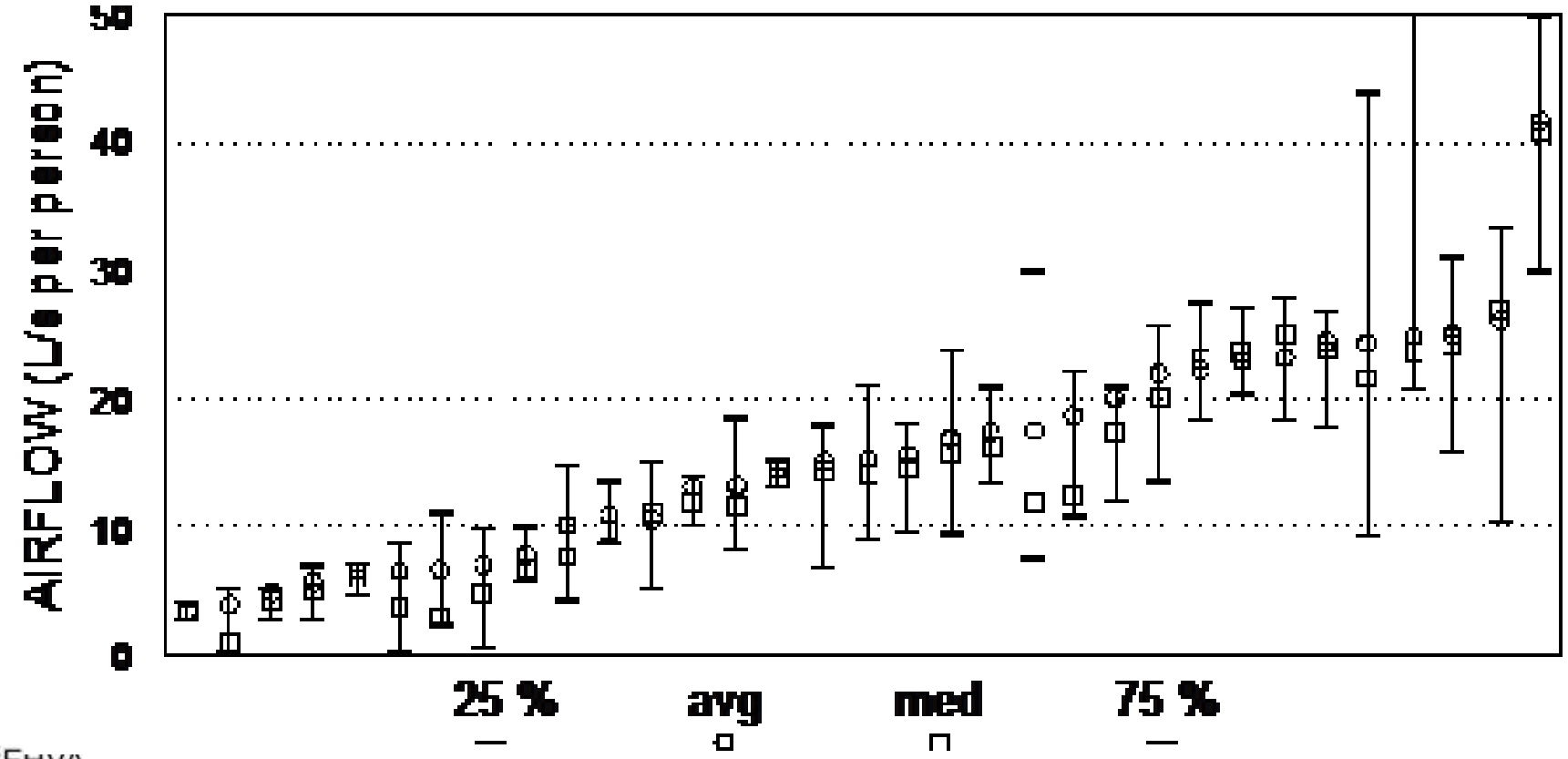
(ClimaMed 2013 Conference)



National ventilation requirement for an office



Ventilation rates vary in and between buildings – random sample of 33 office buildings in Helsinki, Finland



Limit values of pollutant concentrations in national regulations

- **Wide ranges of values**
- **Often higher than given by WHO**
- **Maximum or average limits**
- **Averaging period varies**
- **Only a few pollutants are included in the national regulations**

Limit values for some pollutants

	WHO	FI	LT	NO	PT	RO	SI
Ammonia [µg/m³]	-	20	40	-	-	-	50
Asbestos	-	0 fb/cm	0.1 mg/m³	0.1 fb/cm	-	-	-
CO [mg/m³]	7#2	8	3	10#5	12.5	6#3	10
CO_2 [ppm]	-	1200	-	1000	1000	-	1670
Formaldehyde [µg/m³]	100	50	10	100#3	100	35#3	100
NO_2 [µg/m³]	40	-	40	100#4	-	-	
Ozone [mg/m³]	0.1#5	-	0.03	-	0.2	-	0.1
PM_{10} [µg/m³]	20	50	50	-	150	-	100
Radon [Bg/m³]	-	200#1	-	100	400	140#6	400
Styrene [µg/m³]	-	1	2	-	-	-	-

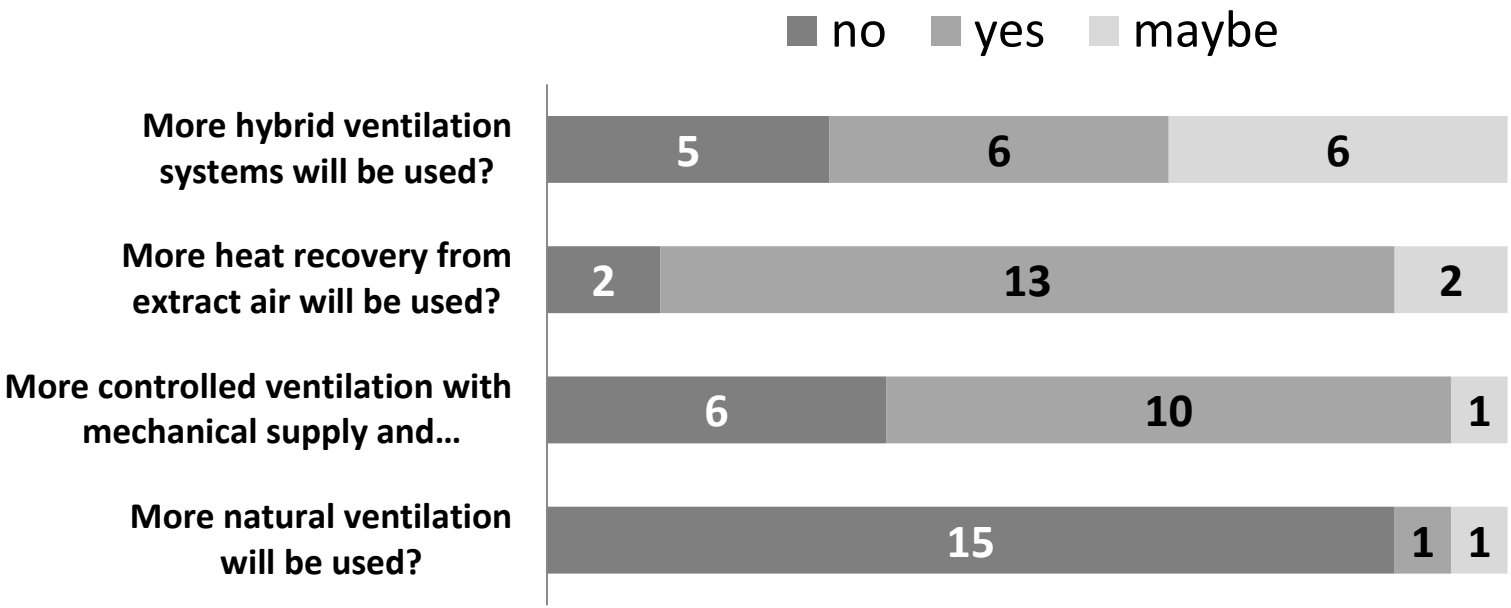
#1 – annual average
#2 – daily maximum
#3 – 30 min average
#4 – 1 h average
#5 – 8 h average
#6 – instant max

Future development of ventilation regulations

Some responses from HealthVent experts regarding the development of national ventilation regulations (17 countries)

- **Majority thinks that regulations will be revised soon (65%)**
- **IAQ problems are expected to increase in the future with EPBD implementation (53%)**
- **IAQ will be included in future ventilation regulations (90%)**
- **Building envelopes will get more air tight (88%)**
- **Mechanical ventilation will become more common**

Some responses from experts regarding the technical development



Technical features in national regulations

% of countries <u>without any requirements</u>:

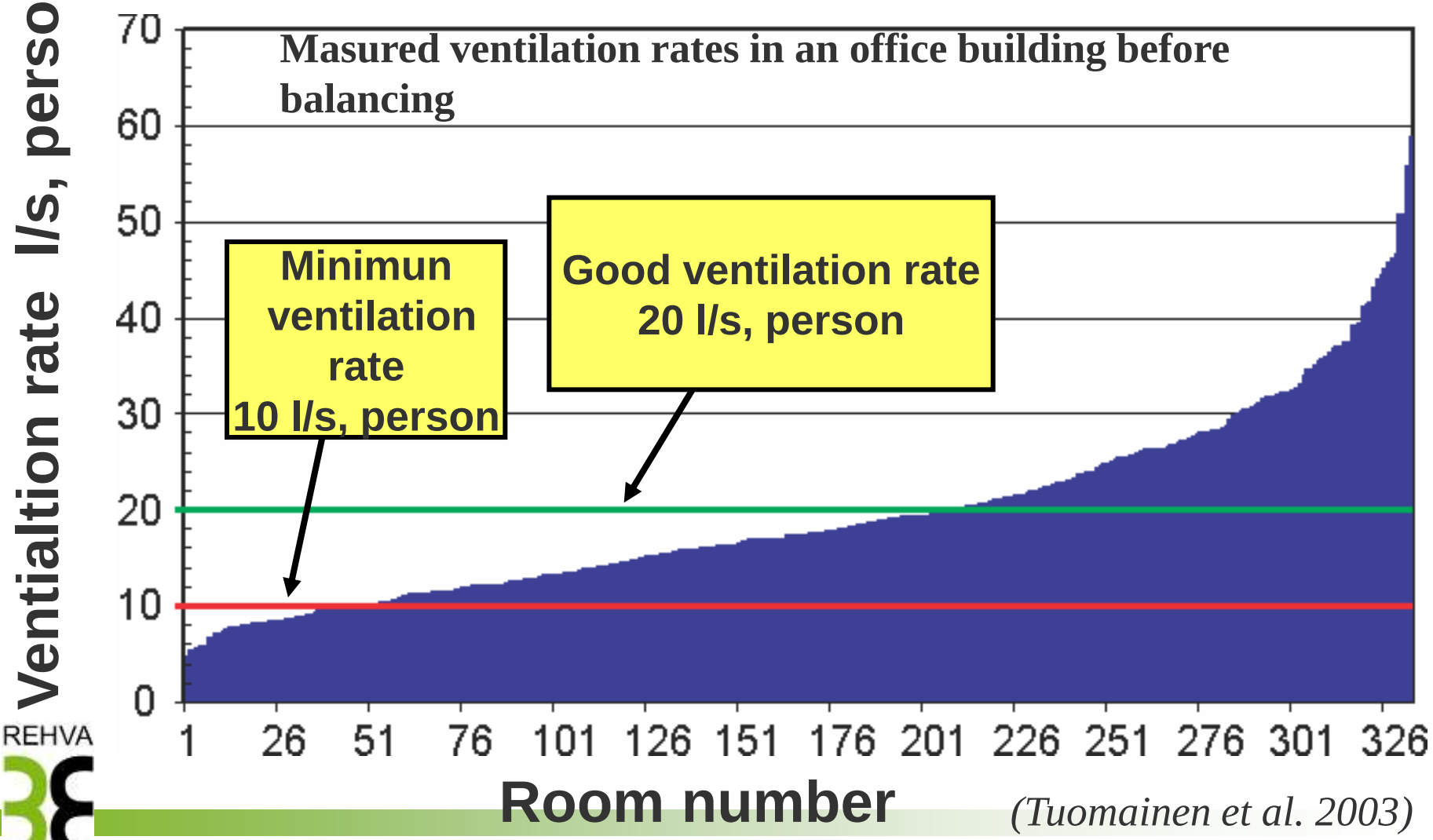
- **90% – location of outdoor air inlet**
- **60% – balancing of air flows**
- **60% – avoiding condensation**
- **55% – operation personnel qualification**
- **50% – protection against outdoor pollutants indoors**
- **50% – cleaning the ventilation system during lifetime**
- **30% – air filtration**

<u>CONCLUSION: Better technical regulations are needed on national level</u>

Good indoor air quality and energy efficiency are not necessary conflicting goals

Four simple examples

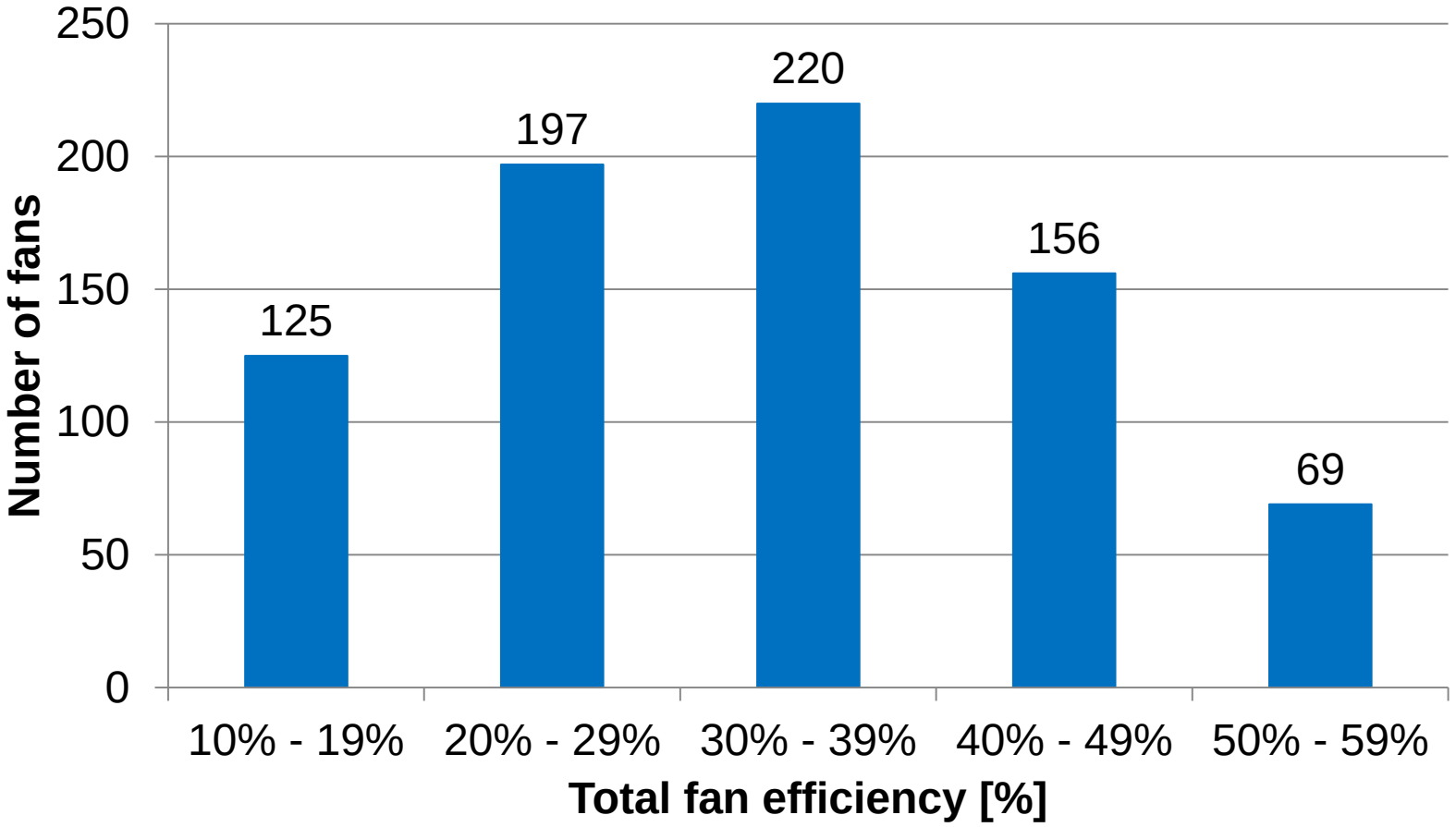
Balancing of ventilation saves energy and improves air quality



(Tuomainen et al. 2003)

Improve the efficiency of fans

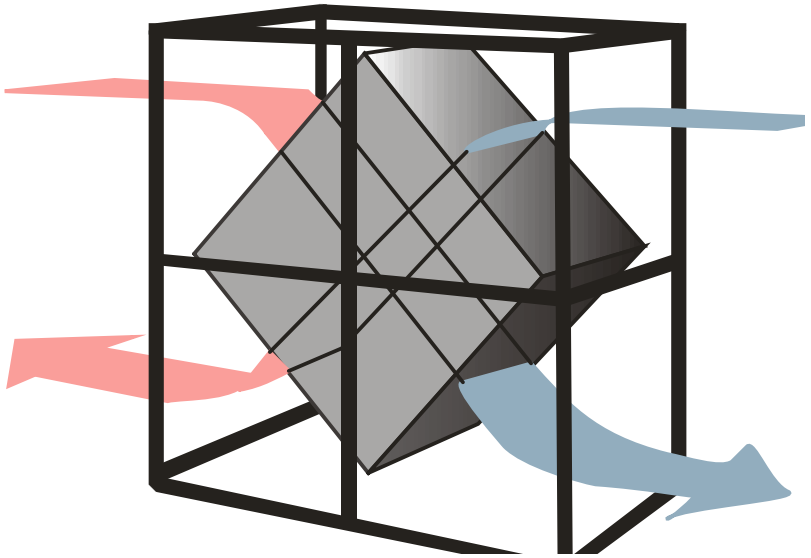
Measured total fan efficiency from a random sample of 767 fans in Sweden



EU- Ecodesign regulation for fans requires much better efficiencies

Heat exchangers for heat recovery from ventilation air

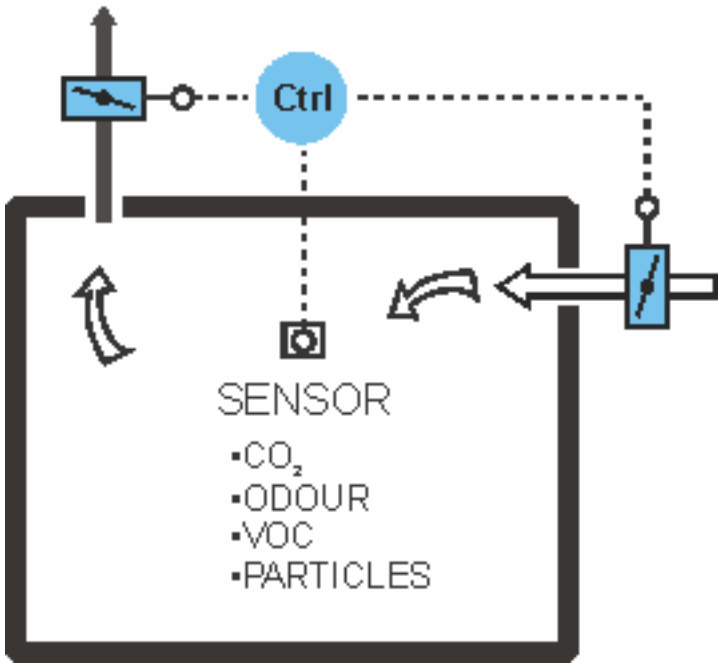
with efficiency of 40 – 90%



- Various materials
- Easy to clean
- By-pass control of supply air temperature
- Freezing to be controlled

Demand Controlled Ventilation Saves Energy without Sacrificing the Air Quality

- **Ventilation rates are controlled by an air quality indicator such as**
  - CO_2, CO, moisture, VOCs, number of occupants,
  - occupancy
- **Cost effectiveness improved with**
  - high air flow, longer operation hours, and cost of energy used for heating and cooling of air



Principles of indoor air quality and ventilation guidelines

I Reduce the emission from indoor sources

(Clean materials, no moisture damages etc.)

II Design and operation of ventilation

A Reduce exposure to pollutants with ventilation

(local exhausts , air flows from cleaner to dirtier spaces etc.)

B Avoid specific sources of pollution related to ventilation system

(avoid drawing in polluted outdoor air, keep the vent system dry and clean etc.)

C Operation and maintenance of ventilation

(training, clear instructions etc.)

Important sources to be used and referred in the national building codes

EN 15251: 2007. Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics, CEN, 2007.

EN 13779:2007. Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems, CEN, 2007.

HealthVent Reports, at http://www.healthvent.byg.dtu.dk/
and
www.rehva.eu>EU projects>HealthVent>report (WP5)
Existing buildings, building codes, ventilation standards and ventilation in Europe