Building services for better indoor air quality

Olli Seppänen

Professor at Helsinki University of Technology

Secretary General of REHVA, Brussels

Assessment of the BoD impacts of diseases, exposures, **sources** and policies

Disease, symptom

SBS, sensory irritation

Asthma & allergy

Infectious diseases

Lung cancer

CV-diseases

COPD

Acute toxication

Indoor exposure

VOCs

Combustion products

Bioaerosols

Pathogens

Radon

CO

Source of indoor exposure

Ambient outdoor air

Building materials

Combustion equipment

Ventilation and air conditioning systems

Water systems, dampness and mould

Furnishings, decoration materials & electrical appliances

Cleaning and other household products

Soil beneath

BoD impact (DALY / individual)

Policies

Integrate IAQ into the EPBD procedure for buildings

Implement European harmonised protocols to test and label building materials, equipment and products

Require systematic documentation and operating, inspection and maintenance manuals for buildings and installations

Mandate radon safe construction for all new buildings

Assign qualified and trained person with control of building documentation and responsibility for building tasks

Mandate tight building envelopes, balanced ventilation and air cleaning if AAQ below WHO AQG

Equip combustion devices with flues & exhaust hoods, mandate CO detectors & regular maintenance/inspection

Implement ventilation guidelines to control moisture, temperature and exposure to indoor and outdoor pollutants.

Mandate regular inspection and maintenance for ventilation and air conditioning systems

Implement moisture control guidelines for building design and maintenance to prevent dampness and mould

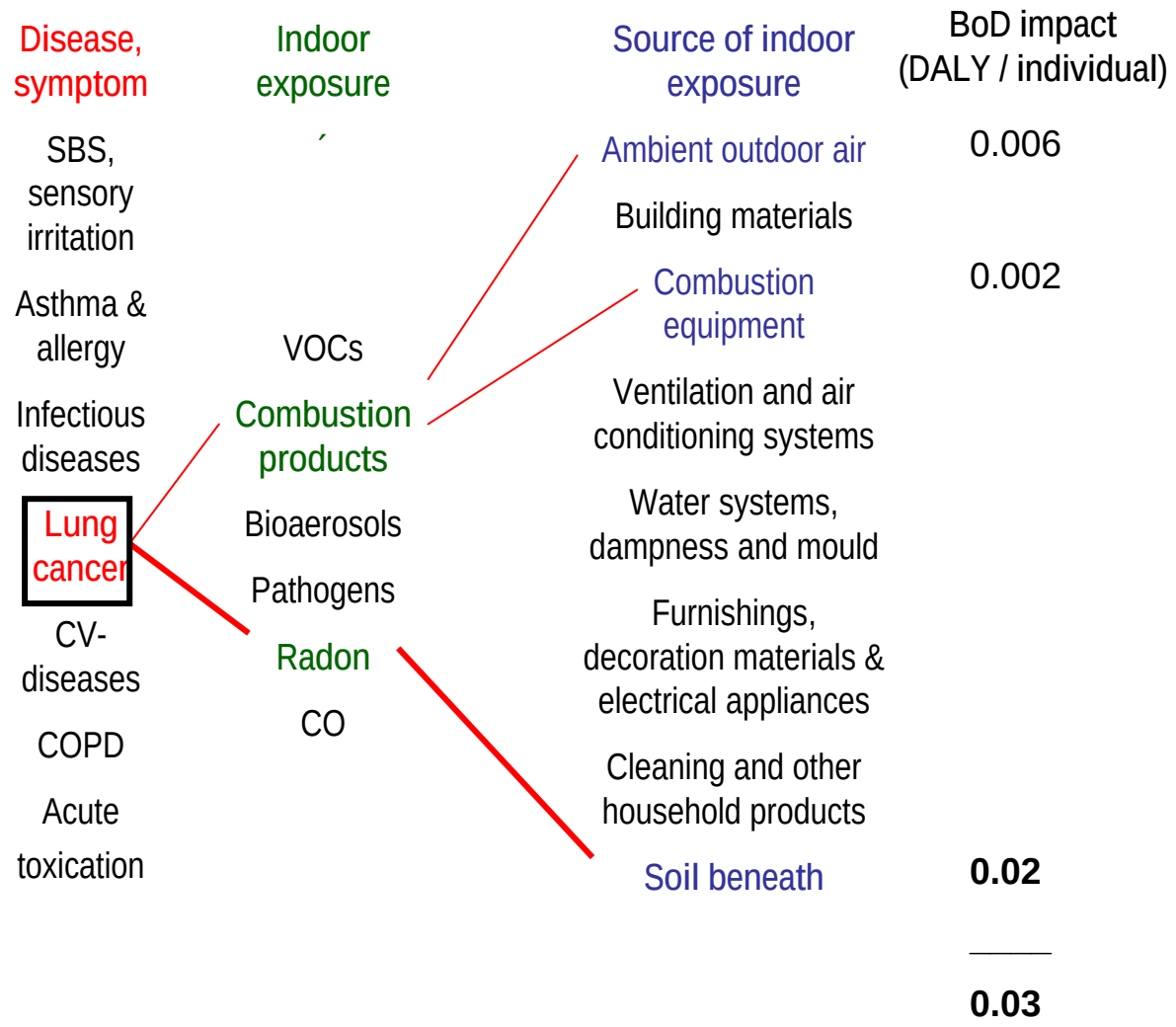
Keep domestic hot water temperature above 55 ºC

Provide kitchens, bath- and laundry rooms with controlled extract ventilation and waterproofed surfaces

Avoid spaces, structures and materials which would not dry by convective airflows

Policy impact (DALY / individual)

Linking a **disease, lung cancer,** to indoor exposures and sources

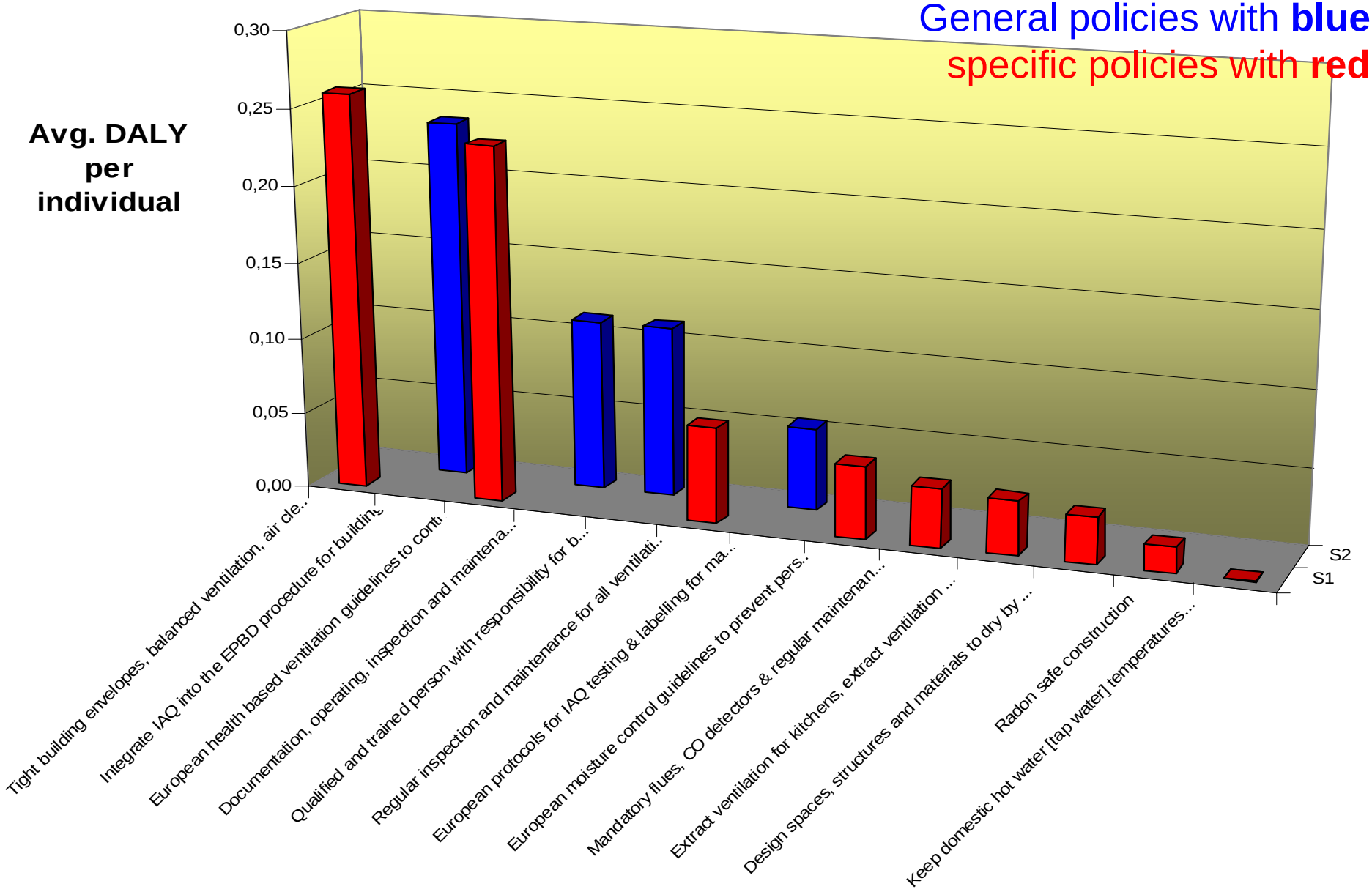


Development of policies

1. **Policy options: all EnVIE partners**
2. **Procedure and model to evaluate the policy by Matti Jantunen, Finnish Public Health Institute**
3. **Evaluation of policies (numbers in the model) by the group:**
   - **Eduardo de Oliveira Fernandes**
   - **Matti Jantunen**
   - **Paolo Carrer**
   - **Stelios Kephalopoulos**
   - **Olli Seppänen**

Potential **public health gains** in Europe for different IAQ policies

General policies with **blue**
specific policies with **red**

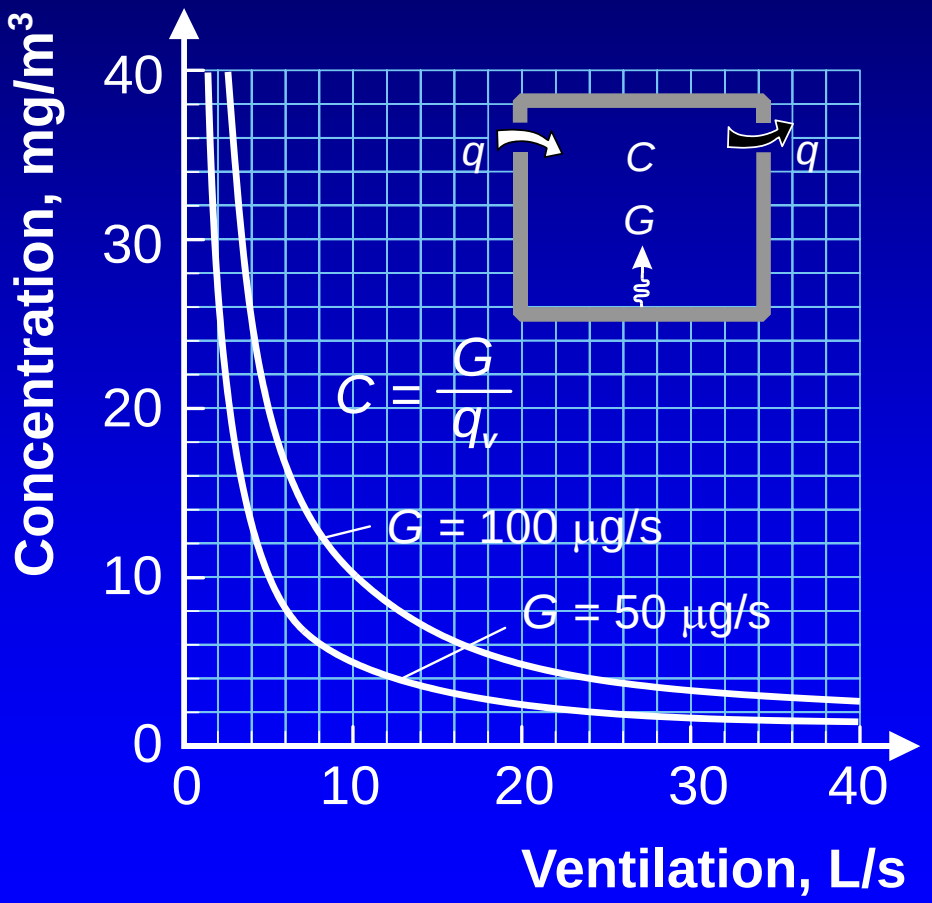


Some EnVIE recommendations related to building services

- Develop European health based ventilation guidelines
- Integrate IAQ into the EPBD inspections and certifications for buildings
- Documentation and operating, inspection and maintenance manuals for all installations
- Assign for each building a sufficiently qualified and trained person with control of all building documentation and responsibility for all building related tasks
- Mandate regular inspection and maintenance for all ventilation and air conditioning systems (integrate to EPBD)
- Ban all unflued combustion heaters ,and equip gas stoves with exhaust hoods and fans

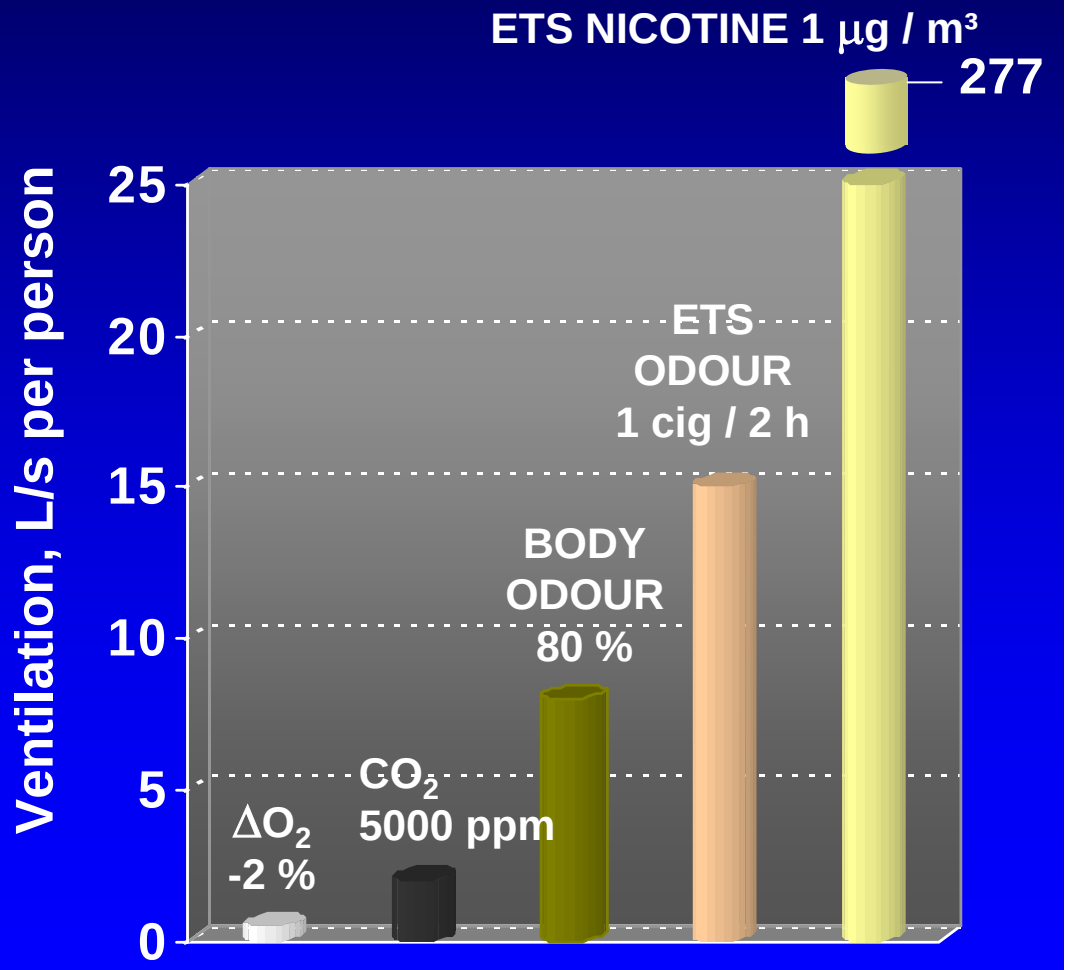
Effect of ventilation rate on pollutant concentration in a space

- The pollutant concentration is proportional to pollution generation and inversely proportional to ventilation rate



Ventilation rate per person depends on the criteria

- Oxygen is never the critical criteria
- CO2 concentration is seldom critical but can be used as indicator
- Acceptable long term level of ETS cannot be achieved with ventilation



European standard EN 15251:2007

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

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

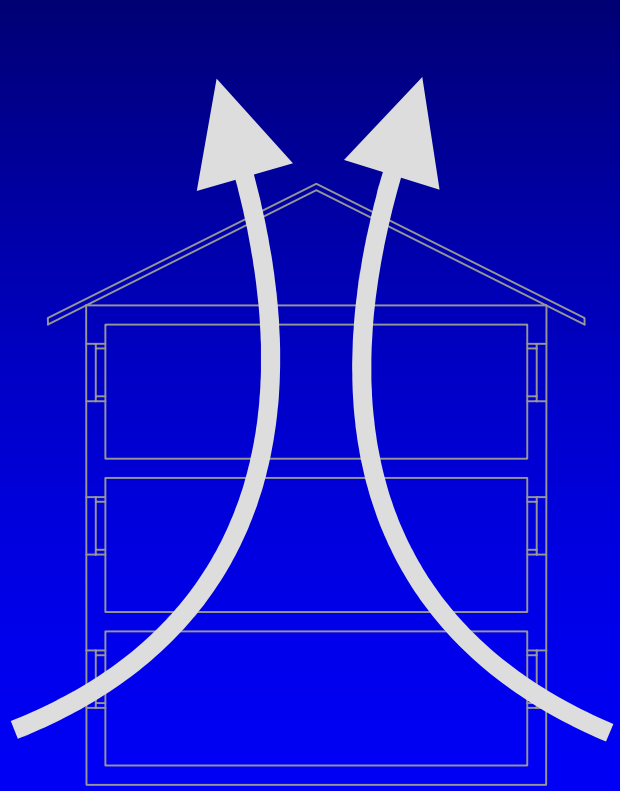
$q_{p\ is}$

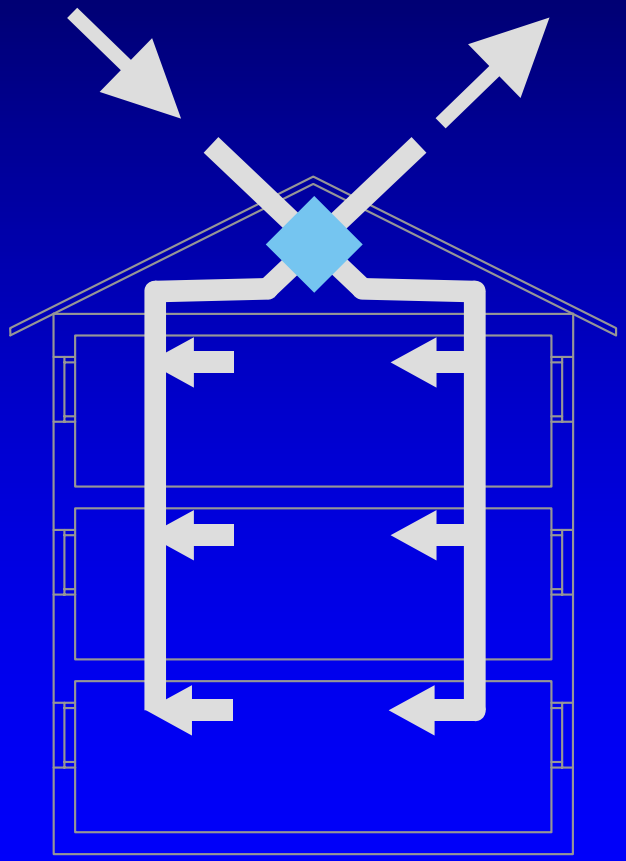
Cat I: 10 l/s,pers Cat II: 7 l/s,pers Cat III: 4 l/s,pers

$q_{B\ is\ for}$

	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

Natural, mechanical or hybrid ventilation





Natural

+ no fan energy
+ lower HVAC first cost
+ less SBS symptoms
- outdoor pollutants and noise
- temperature fluctuation
- high air velocities
- no heat recovery
- limited control of pressure differences
- needs skilled integrated design

Mechanical

+ controlled air flows, pressure differences and IAQ
+gives flexibility in architectural design
+heat recovery, air cleaning
- needs fan energy
- higher HVAC first cost
- hygienic problems with air handling systems
- needs skilled operation and maintenance

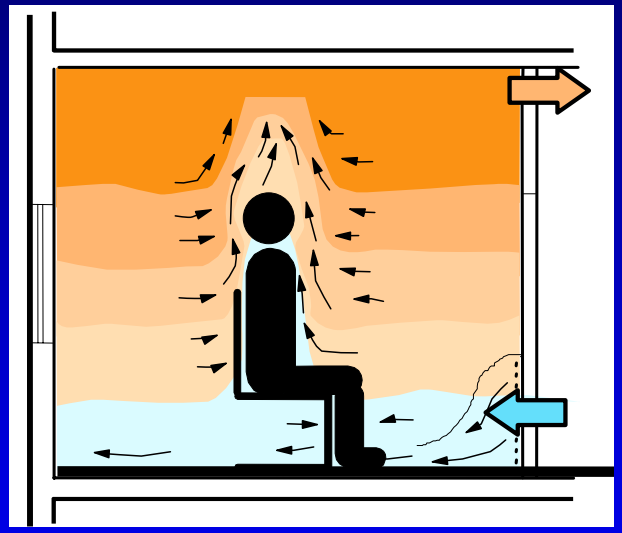
Good and bad systems exist –
skillful design and installation required for both systems

New ventilation guidelines are needed

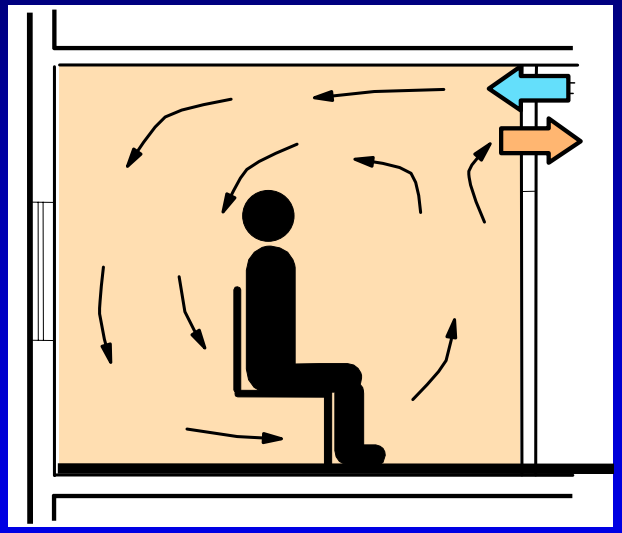
- From prescriptive guidelines to performance based ventilation guidelines
- Similar performance requirements for all systems (Copenhagen 2008 results)
- From air flows prescription to concentrations or long term exposure with varying air flows (evaluation of mechanical, hybrid, and natural ventilation)
- Allow innovative systems and give credits for new systems (energy use and air flows)

Examples of innovative systems that do not get any credits in currents standards

Same air quality with lower air flow



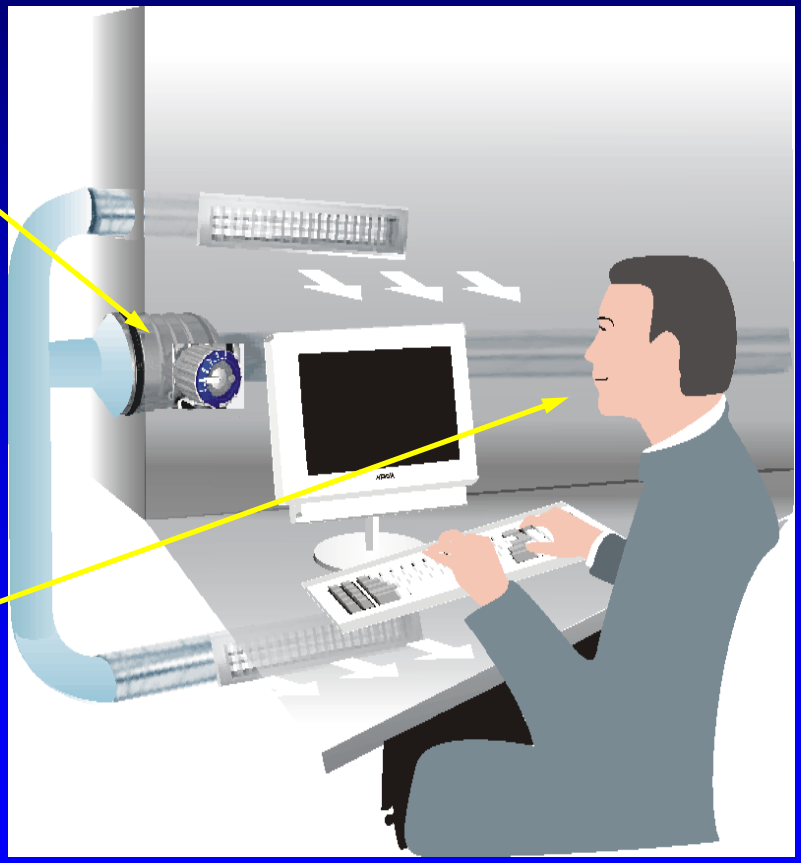
6 - 8 L/s
=
10 L/s



(Skistad et al. 2002, Rehva Guidebook no 1 on Displacement Ventilation)

Task Ventilation Improves IAQ and Energy Efficiency

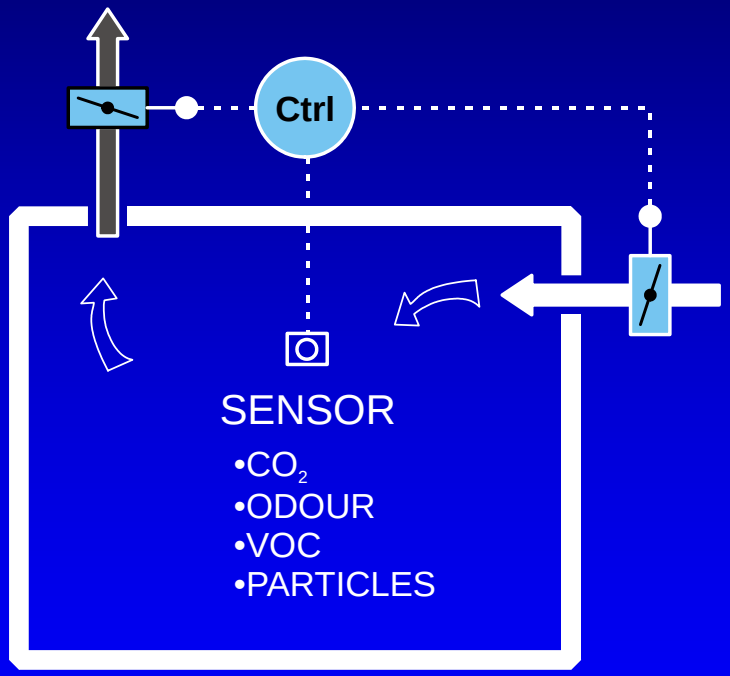
- Offers occupants an option of individual control of IAQ
- Saves heating, cooling and fan energy
- Improves productivity



Demand Controlled Ventilation Saves Energy

- Ventilation rates are controlled by an air quality indicator such as
  - CO_2, CO, moisture, VOCs, number of occupants
- Energy savings

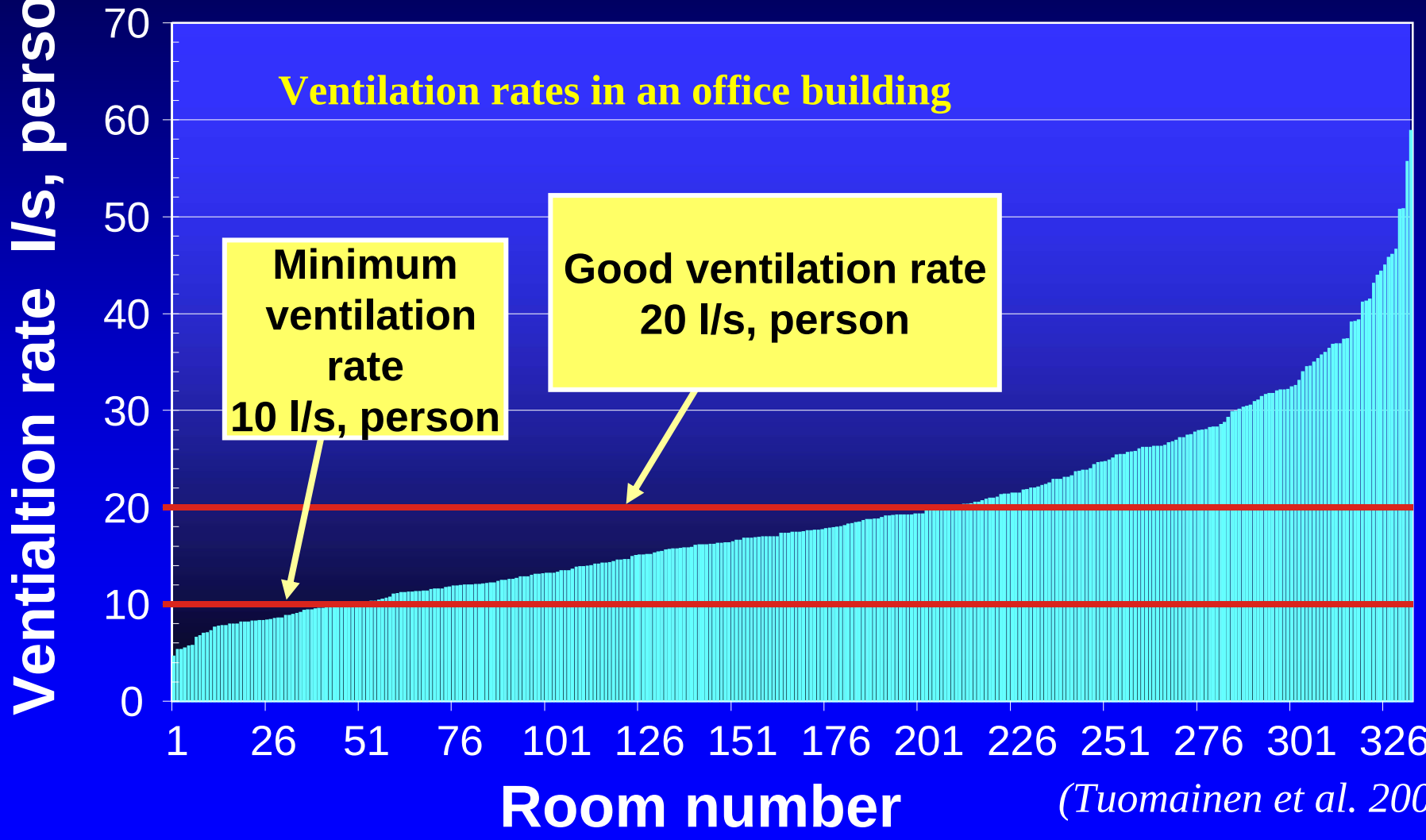
  20 – 70%
- Cost effectiveness improved with
  - high air flow, longer operating hours, and cost of energy used for heating and cooling of air



Better operation and maintenance of buildings

- Operating instructions
- Inspections
- Qualified personnel
- Responsible personnel

Balancing of ventilation save energy and improve air quality



(Tuomainen et al. 2003)

Research results support the importance of good maintenance

- **Good maintenance improves user satisfaction** *(Dorgan et al 1999)*
- **Lack of regularly scheduled inspections for HVAC components was associated with increased eye and upper respiratory symptoms (ORs=2.2, 1.6) (Mendell at al 2007)**
- **Less frequent cleaning of cooling coils or drip pans was associated with increased headache and eye symptoms (ORs=1.5, 1.5). (Mendell at al 2007)**
- **Buildings now often more complex than before**
- **Operation and maintenance instructions missing in 50% of Swedish buildings** *(Engdahl 1998)*

Criteria for Labeled HVAC Components

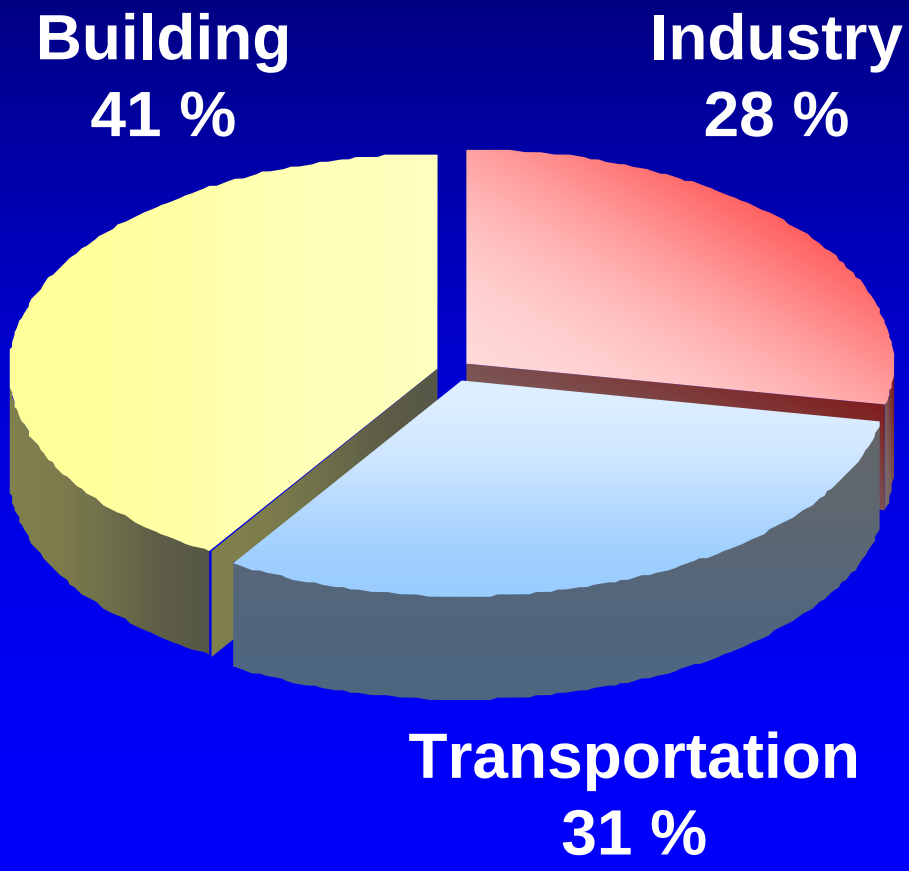
(Finnish Classification of Indoor Climate and Building Products 2001)

- **Oil concentration g/m² of**
  - **ducts** **<0.05**
  - **terminal units and dampers** **<0.05**
  - **pressed components** **<0.3**
- **Mineral fibres (MMVF), f/cm³** **<0.01**
- **Dust concentration, g/m²** **<0.5**
- **Odour**
  - **acceptability of air quality passing through the compo-nents better than** **0.05**

Energy and indoor environment

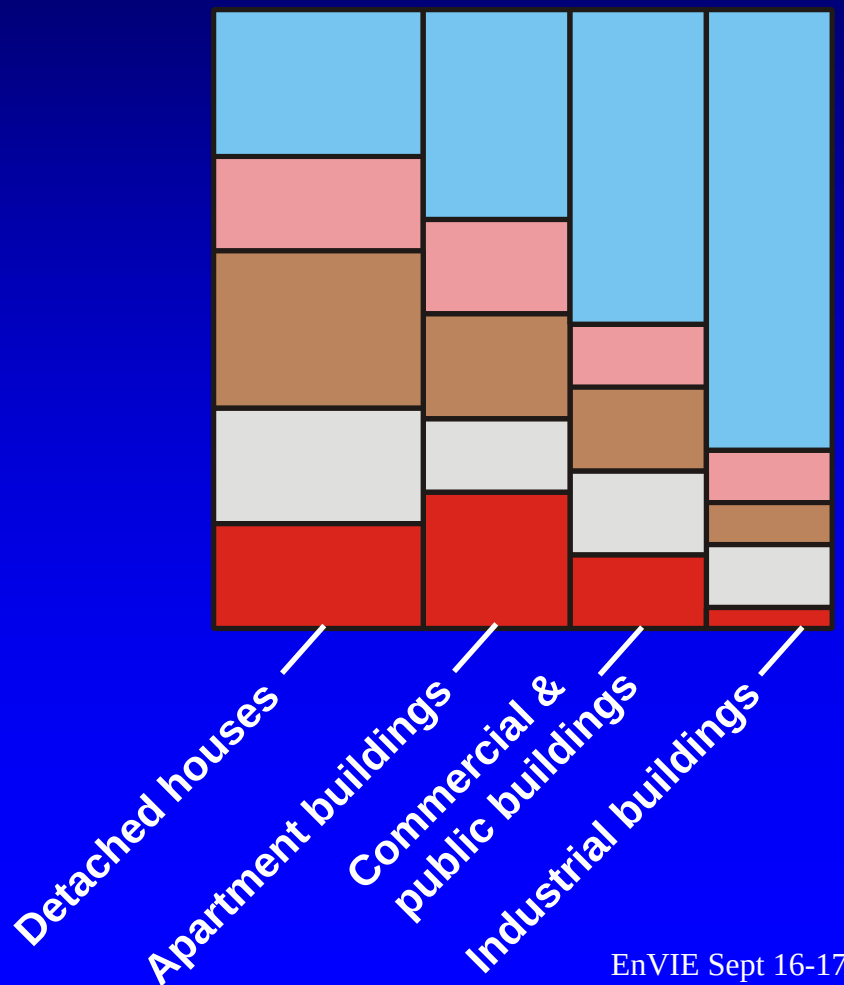
Energy use in buildings

- Over 40% of primary energy is used in buildings in the US and EU countries
- From delivered energy 2/3 for space conditioning



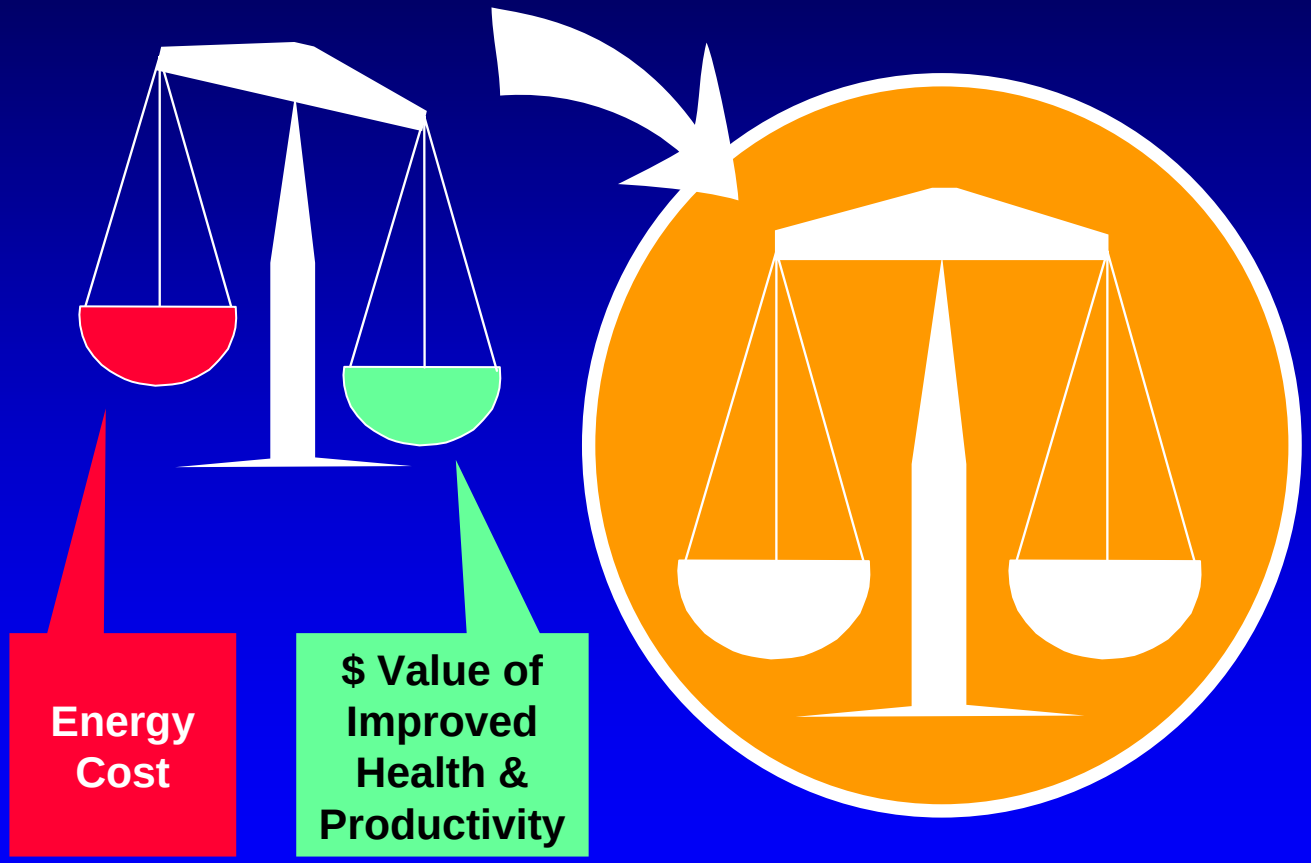
Breakdown of heating energy use of buildings in Finland

- Ventilation
- Windows
- Walls
- Roof & base floor
- Hot water



Areas in the square are proportional to heating energy loss

The Basic Challenge



More ventilation

- Increased heating and cooling energy
- Better work performance and health

Air Conditioning

- Increased cooling energy
- Better work performance

Integrate IAQ with EPBD and EuP

- Energy certificate does not make any sense if it does not include information on IAQ
- IAQ should be integrated in mandatory inspections of air conditioning and ventilation systems
- Regulations of ecodesign of energy using products should include the IAQ aspects – now 26 product groups under development

Indoor generated combustion products

- Avoid gas fired cooking appliances
- Do not use unvented gas heaters of space or domestic hot water
- Use always effective range hood in kitchen
- Provide an effective ventilation system to kitchens

Win-win strategies that at the same time improve indoor air quality and reduce energy use

- **Use low emission building products**
- **Ban smoking indoors**
- **Use high efficiency air distribution in rooms**
- **Use free cooling when weather permits**
- **Balance the supply air flows**
- **Recovery heat from exhausted ventilation air**
- **Control ventilation by demand**
- **Use task ventilation when feasible**

Conclusions

- Energy efficiency and good IAQ are not necessary conflicting requirements
- European level guidance is needed for better IAQ on different levels
- IAQ has to be integrated in several area within EU (CPD, EPBD, EuP, Energy production, CHP, Consumer safety etc)
- Proper tool at the moment seems to be a Green Paper based on the EnVIE summary report (REHVA and EFA support also this conclusion)
- Engineers and architects make thousands of IAQ decisions daily based on limited knowledge on IAQ
- EnVIE has shown that we have enough information to build better buildings – we should act now– timing is correct (Prof Seifert)