AMCA International

Energy-Efficient Ventilation Systems and Indoor-Air Qaulity

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Air System Engineering & Technology (ASET) Conference–Europe

Lyon, France • L'Espace Tête d'Or • 20 February 2018

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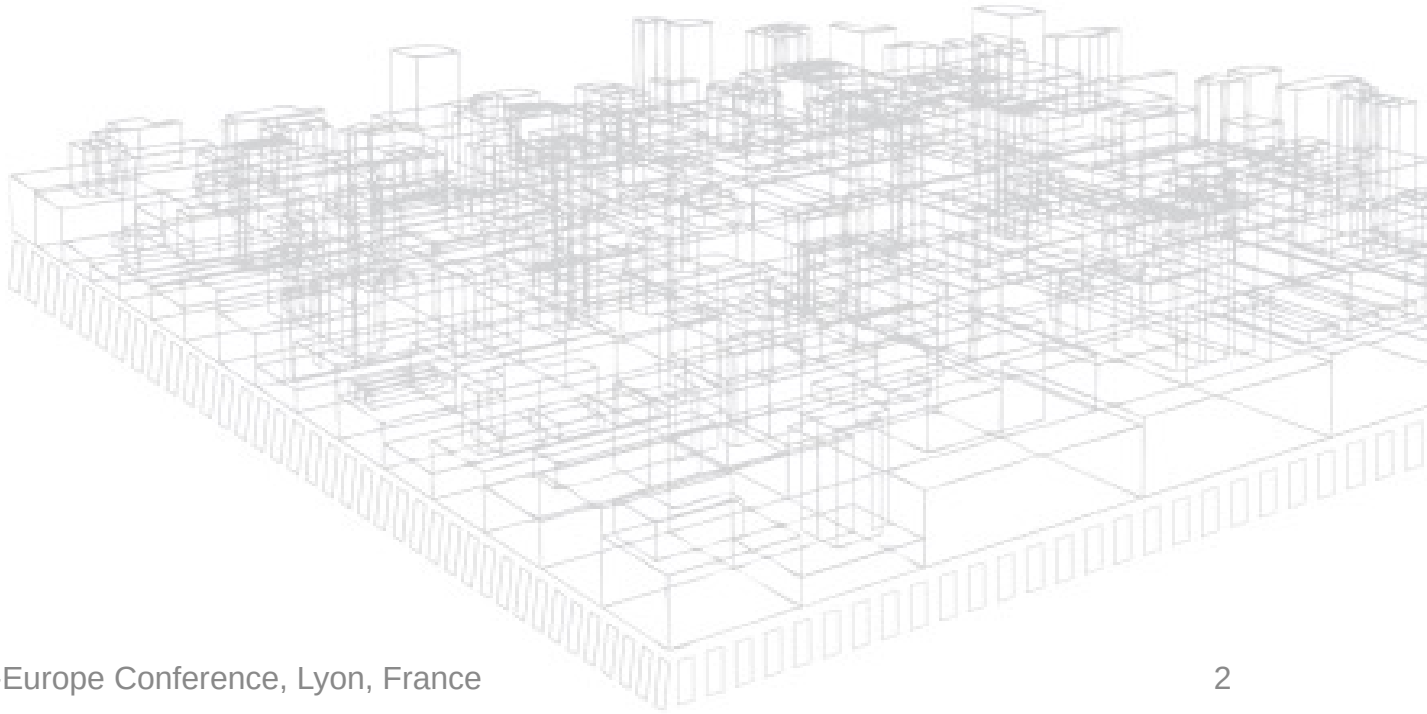


Learning Objectives

- Indoor Environment Quality and Indoor Air Quality
- Contribution of of fan assisted ventilation systems on IAQ
- European legislation and IAQ
- Energy Performance of Buildings Directive revision 2018 and IAQ
- Outdoor Air Quality – Supply Air Quality – Indoor Air Quality
- Filtration and fine dust
- Information on IAQ
- European Market for Residential Ventilation Systems

Indoor Environment Quality -> Indoor Air Quality

- **Light**
- **Acoustic**
- **Smartness**
- **Thermal Comfort**
  - Summer/winter temperature/humidity
  - Draft risk
- **Indoor Air Quality - Ventilation rate:**
  - The right amount
  - At the right time
  - At the right place
- **Regular Inspections to ensure functionally and**
- **minimum energy consumption**

AREA · ehpa european heat pump association · EPEE The voice of the heating, cooling and refrigeration industry · eu.bac european building automation controls association · euha ELECTRIC UNDERFLOOR HEATING ALLIANCE A sustainable, smart & comfortable future · EUROVENT · EVIA European Ventilation Industry Association · GCP EUROPE The voice of Efficient building engineering services · REHVA Federation of European Heating, Ventilation and Air Conditioning Associations

September 2017

Energy Performance of Buildings Directive:
A once-in-a-decade opportunity to strengthen Indoor Environment Quality

Position of industry and professional associations

On 11 October 2017, the Parliament's Industry committee will adopt its report on the revision of the Energy Performance of Buildings Directive.

With one in six Europeans living in unhealthy buildings[1], 2 million healthy years are lost in the EU every year due to poor indoor air quality. This review is a once-in-a-decade opportunity to drive much needed changes and improvements in the existing building stock and to promote systems and solutions that result in higher Indoor Environment Quality (i.e. indoor air quality, thermal comfort, lighting and acoustic environment), lower energy consumption and increase consumer empowerment.

In that context, our associations echo the call of the health community and jointly urge Members of the European Parliament to pay due consideration to Indoor Environment Quality for the sake of citizens' health, comfort and productivity and to support amendments that:

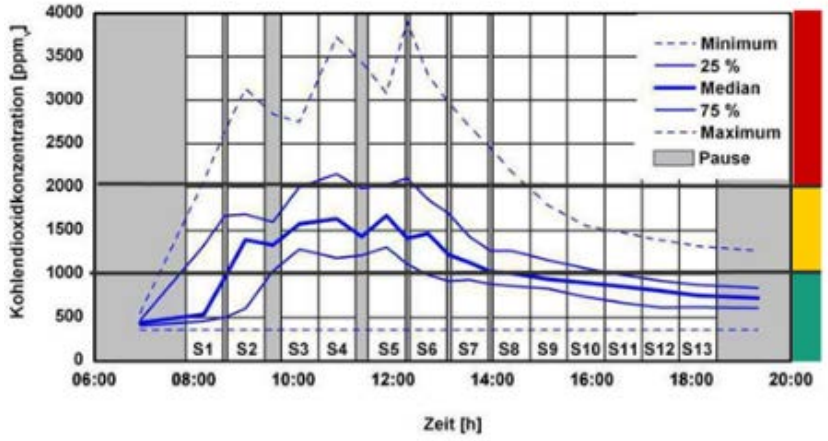
1. **Ensure compliance with the provisions of the existing and revised EPBD to promote refurbishment and create the regulatory conditions for improved Indoor Environment Quality.**
2. **Set regular inspections and continuous commissioning, monitoring and control functionalities of technical building systems to achieve healthier buildings.**
3. **Enhance the ability of occupants and of the building itself to maintain a higher Indoor Environment Quality in actual building usage conditions, and to optimize energy costs.**
4. **Set up requirements to ensure the deployment of smart technologies such as building automation and controls which, by improving indoor environment quality, have positive impact on health and well-being of its occupants.**

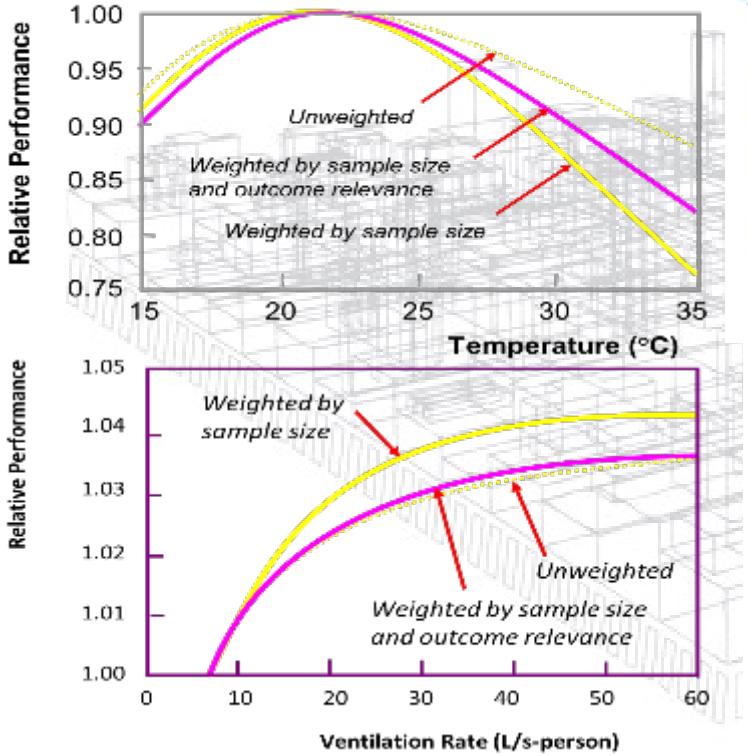
As buildings are getting more air-tight and better insulated, it is essential to ensure that sufficient fresh air is introduced to keep occupants healthy and to protect the building condition. Indoor Environment Quality can be enhanced through use of mechanical ventilation and technical building systems which, when properly maintained, inspected and controlled (including the leakage of ventilation ducts at regular intervals) will deliver positive outcomes on health, productivity and comfort.

IAQ impacts -> Presentation Pawel Wargocki

- **The relation between IAQ, thermal comfort and productivity has been shown in many Studies**
  - Seppänen O, Fisk W , Lei QH (2006) Ventilation and performance in office work. Indoor Air Journal, 16 (1), 28-35.
  - Wargocki, P.; Wyon, D.P.: Effects of HVAC on students performance ASHRAE Journal 2006,S. 22–28
  - B. Olesen DTU Copenhagen
    Schools
  - Hellwig, Antretter, Holm, Sedlbauer, Fraunhofer ISE, 2009

Measurement CO_2 in existing schools
Hellwig, Antretter, Holm, Sedlbauer, Fraunhofer ISE, 2009



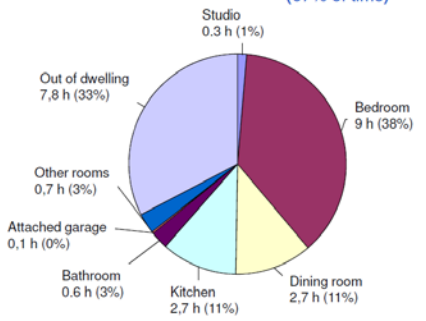


CSTB le futur en construction

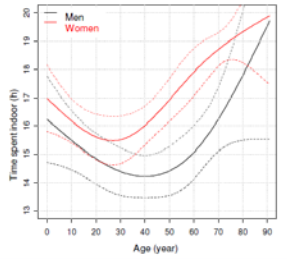
Time spent in dwellings

Source : OQAI – National survey on IAQ in dwellings 2003-2005

Average time spent in dwelling : 16h10mn (67% of time)



Women=17h00 ; **Men**=15h14
¼ of the population spend **more than 20h**
Children under 5 years old and **elderly > 60 ans** stay indoor most of their time



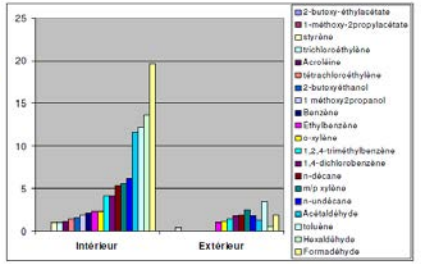
CSTB le futur en construction

French national survey OQAI (2003-2005)
Indoor pollution in housing

Various pollutants (chemical, physical, microbiological) present in most of the dwellings

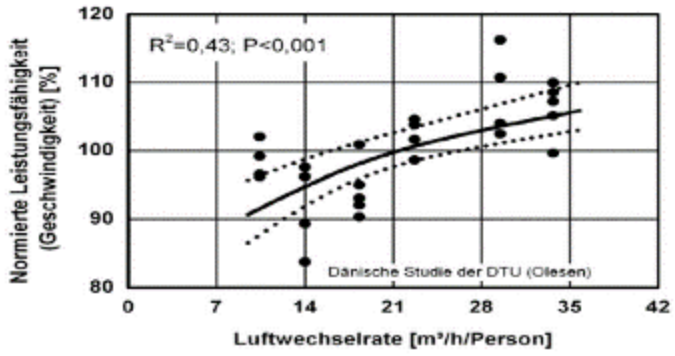
Indoor pollution higher than outdoor

Inequality in pollution exposure : about 10 % of dwellings are multi polluted



Volatile organic compounds

Report available on www.air-interieur.org

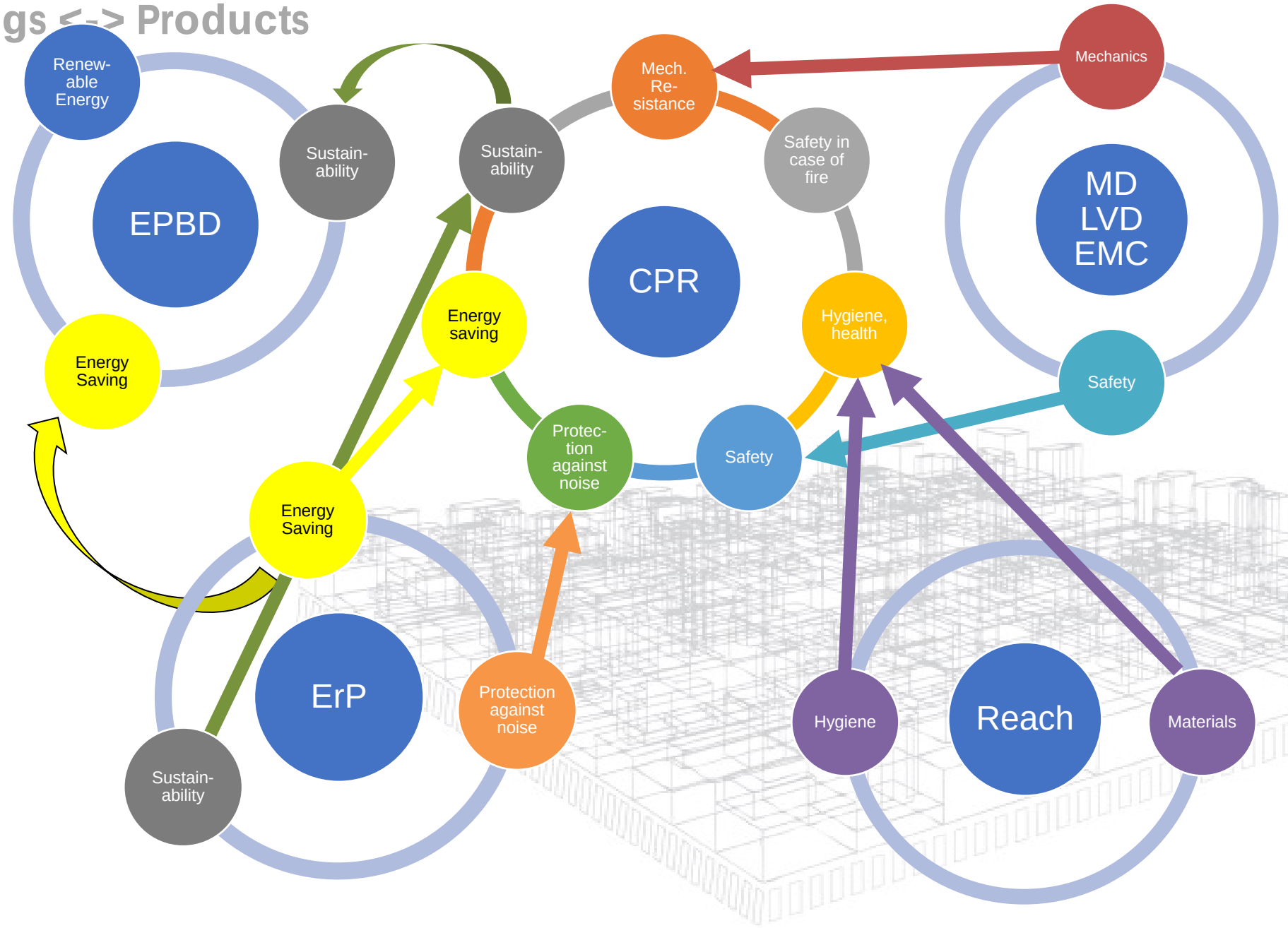


IAQ in Buildings and Ventilation Systems - Basic Aspects

- **Ventilation for Building Protection**
  - Damage Prevention
  - Moisture Prevention
- **Indoor Air Quality**
  - Pollutant removal
  - Perceived Air Quality
- **Outdoor and Outdoor Air Quality**
  - Fine Dust
  - Odours
  - Noise
- **Hygiene aspects of ventilation systems**
  - Maintenance
  - Cleaning

EU-Regulation Buildings <-> Products

- **EPBD: Energy Performance of Buildings Directive**
- **CPR: Construction Products Regulation**
- **ErP: Ecodesign Directive**
- **MD: Machine Directive**
- **LVD: Low Voltage Directive**
- **EMC: Electromagnetic Compatibility**
- **Reach: Chemical Aspects**

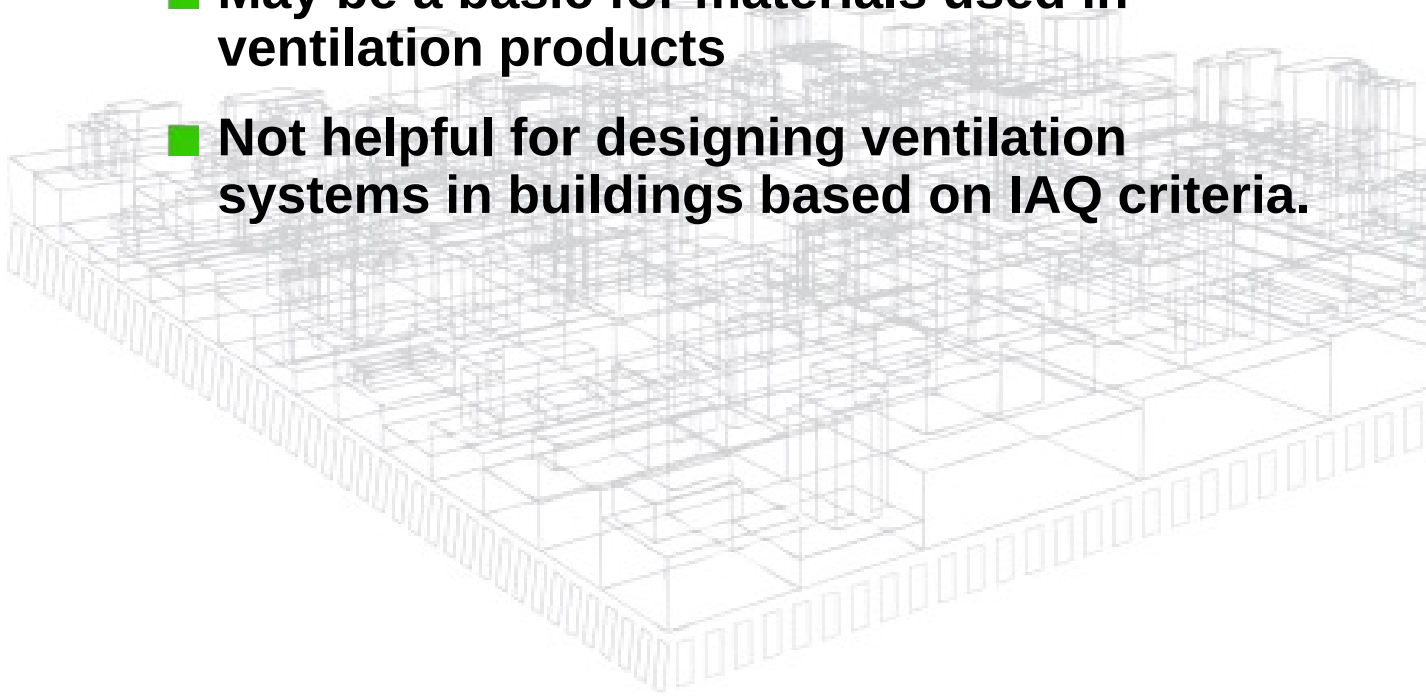


Construction Product Directive

- **Basic requirements only on a product level**
- **System/Building level is national/regional**
- **The focus on IAQ is weak.**
  Key aspects are:
  - Safety
  - Security
  - Energy Savings
  - Material emissions?
  - Building mechanics
- **Is the whole ventilation system part of CPD?**
  The view of member states is different.
  - Parts with safety/fire/smoke yes
  - Other parts different views

Reach-Directive

- **Collecting and assessing information on the properties and hazards of substances.**
- **Basic requirements on**
  - Substances
  - Preparations
- **May be a basic for materials used in ventilation products**
- **Not helpful for designing ventilation systems in buildings based on IAQ criteria.**

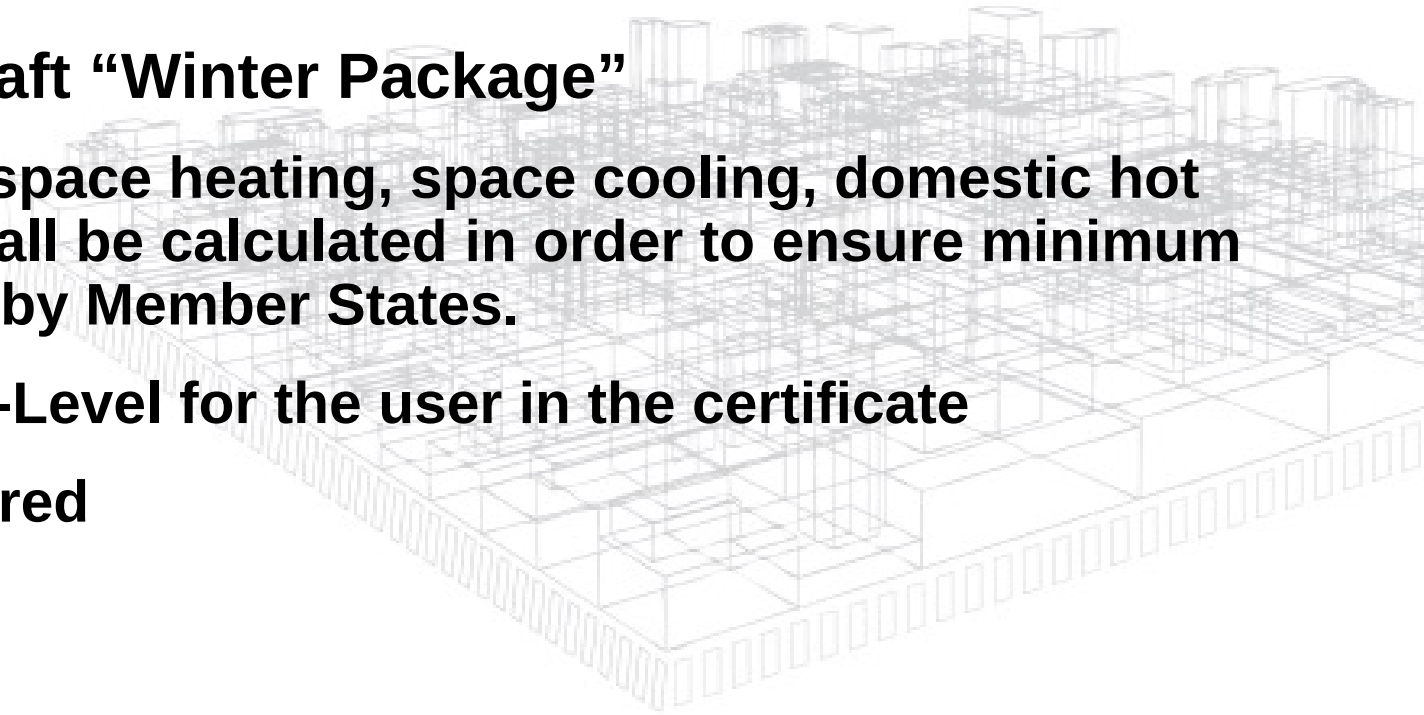


Energy Performance Directive – Current Version EU 2010/31/EU

- Article 4: These requirements shall take account of general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation, as well as local conditions and the designated function and the age of the building.
- No information for the user in the certificate

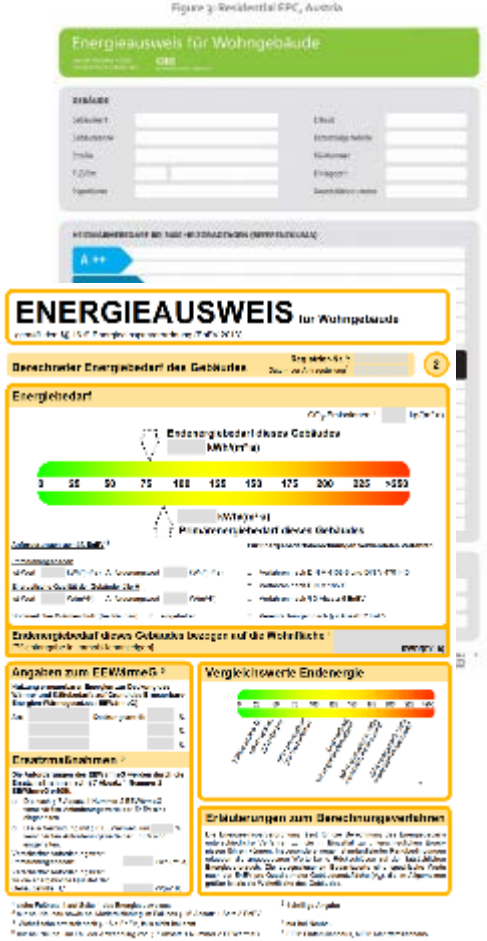
Energy Performance Directive – Draft “Winter Package”

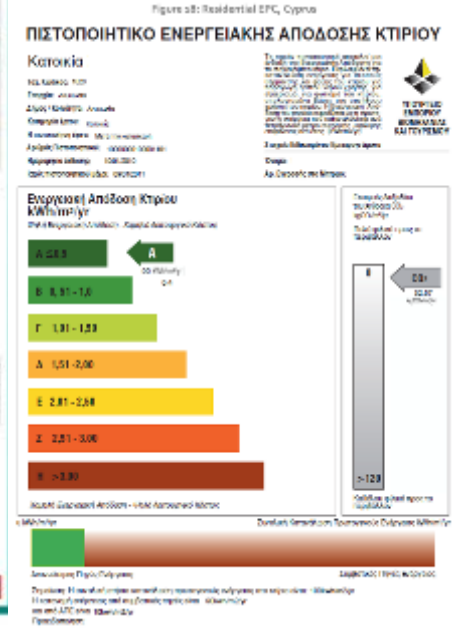
- **Annex I ‘2. The energy needs for space heating, space cooling, domestic hot water and adequate ventilation shall be calculated in order to ensure minimum health and comfort levels defined by Member States.**
- **No mandatory information on IAQ-Level for the user in the certificate**
- **No minimum ventilation rate required**
- **No inspections required**

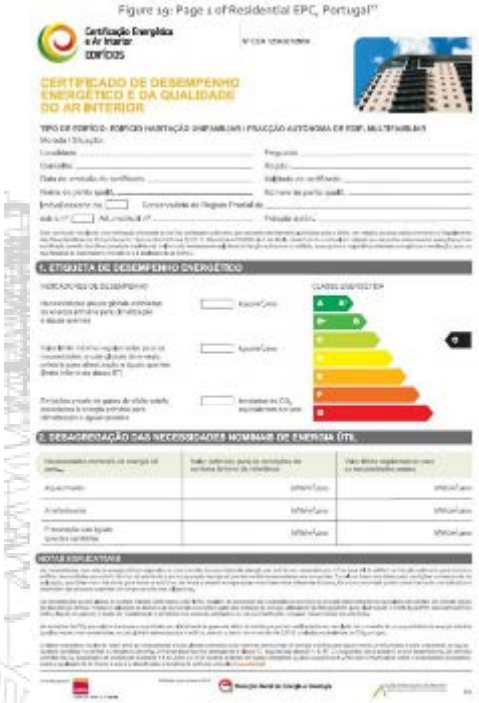


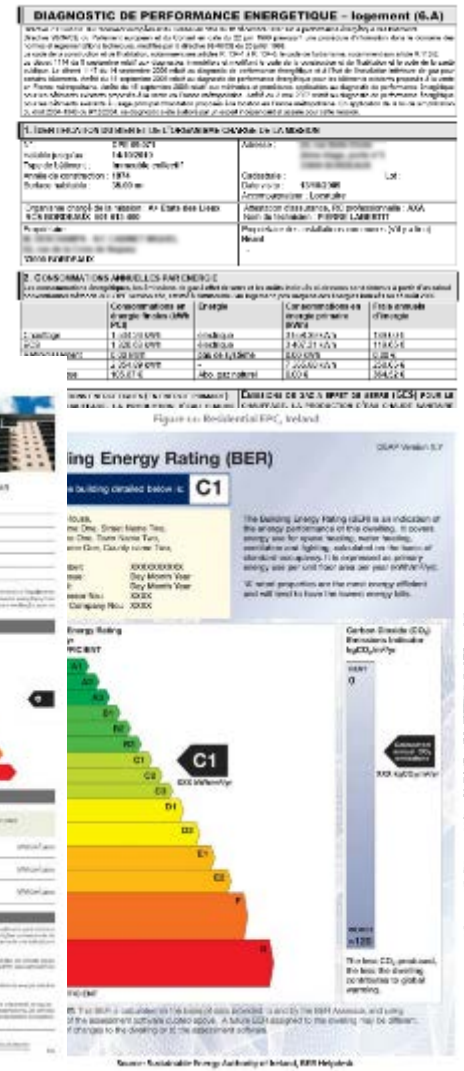
Regulatory Perspective EPBD

Currently - No Indicator for IAQ in Building Certificates







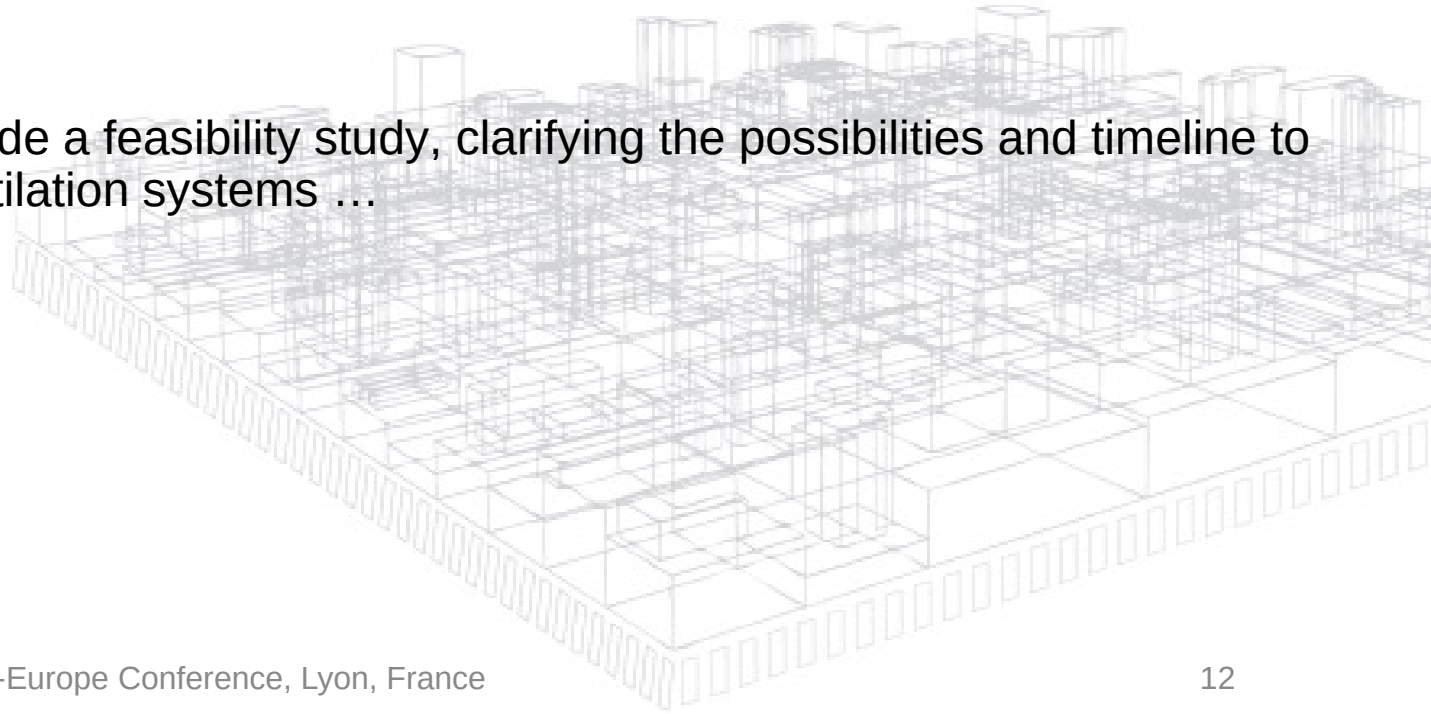


EPBD – Trilog Outcome January 2018

- **(11a) For new buildings and buildings undergoing major renovations, Member States should encourage high-efficiency alternative systems, if technically, functionally and economically feasible, while also**
  - addressing healthy indoor climate conditions as well as …
- **(11b) The 2009 WHO guidelines provide that, concerning indoor air quality, better performing buildings provide higher comfort levels and wellbeing for their occupants and improve health. ….**
- **(12a) Member States should support energy performance upgrades of existing buildings that contribute to achieving a healthy indoor environment, …**
- **Article 2a Long-term renovation strategy**
  This strategy shall be submitted in accordance withthe applicable reporting obligations and shall encompass:
  - (g) an evidence-based estimate of expected energy savings and wider benefits, such as those related to health, safety and air quality.

EPBD – Trilog Outcome January 2018

- **Article 4 Setting of minimum energy performance requirements**
  - These requirements shall take account of general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation, …
- **Article 7 Existing buildings**
  - Member States shall encourage, in relation to buildings undergoing major renovations, … address healthy indoor climate conditions …
- **Article 19a**
  - The Commission shall, before 2020, conclude a feasibility study, clarifying the possibilities and timeline to introduce the inspection of stand-alone ventilation systems …

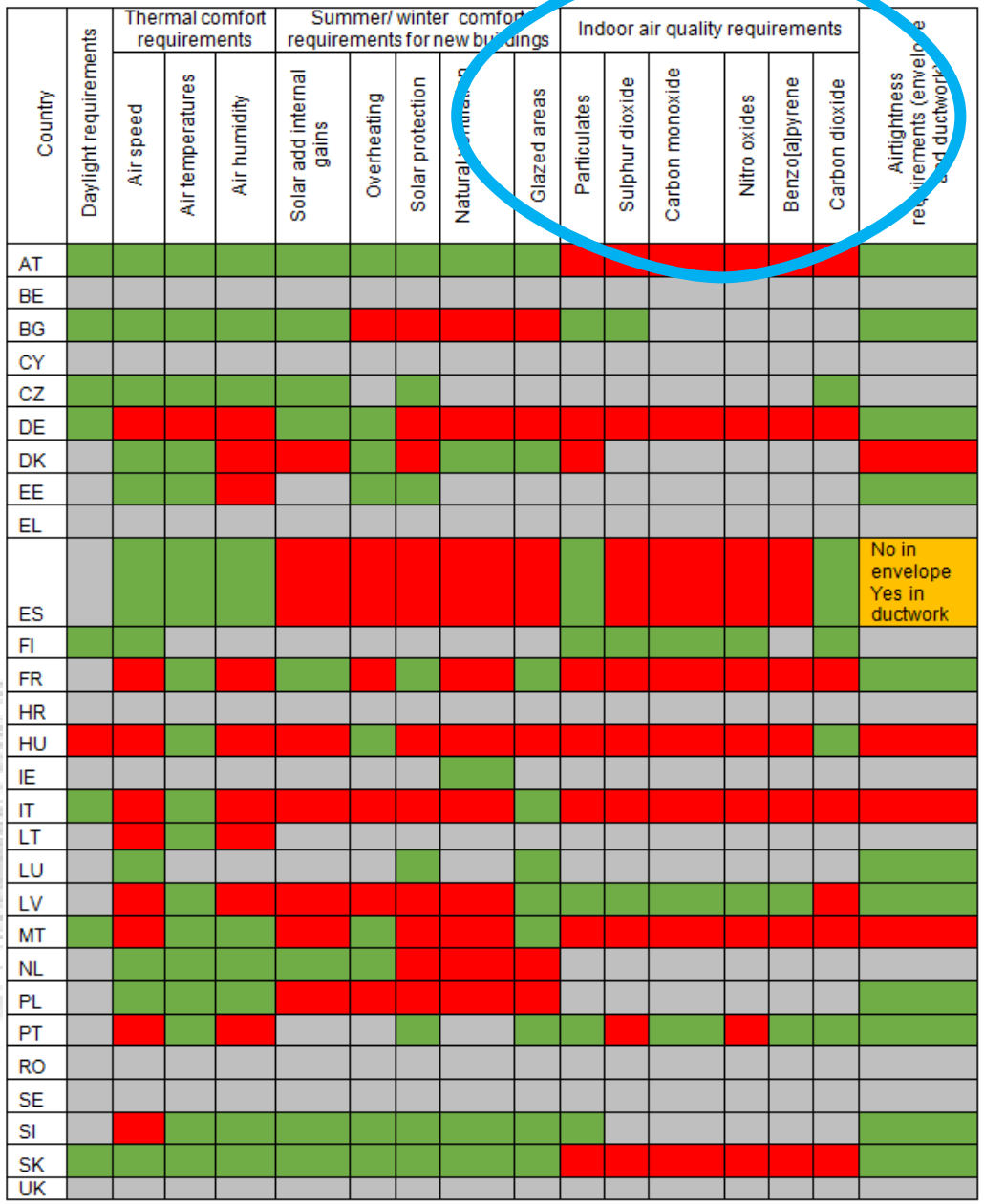


EPBD – Trilog Outcome January 2018

- **ANNEX I Common general framework for the calculation of energy performance of buildings**
  - 2. The energy needs for space heating, …, ventilation and other technical building systems shall be calculated in order to optimise health, indoor air quality and comfort levels defined by Member States at national or regional level.
- **ANNEX Ia Common general framework for rating the smart readiness of buildings**
  - 2 (b) the ability to adapt its operation mode in response to the needs of the occupant paying due attention to the availability of user-friendliness, maintaining healthy indoor climate conditions and ability to report on energy use; and
  - 3. The methodology may further take into account:
    - the interoperability between systems (smart meters, building automation and control systems, built-in home appliances, self-regulating devices for indoor temperature within the building and indoor air quality sensors and ventilations) and …

IAQ in Buildings: State of play

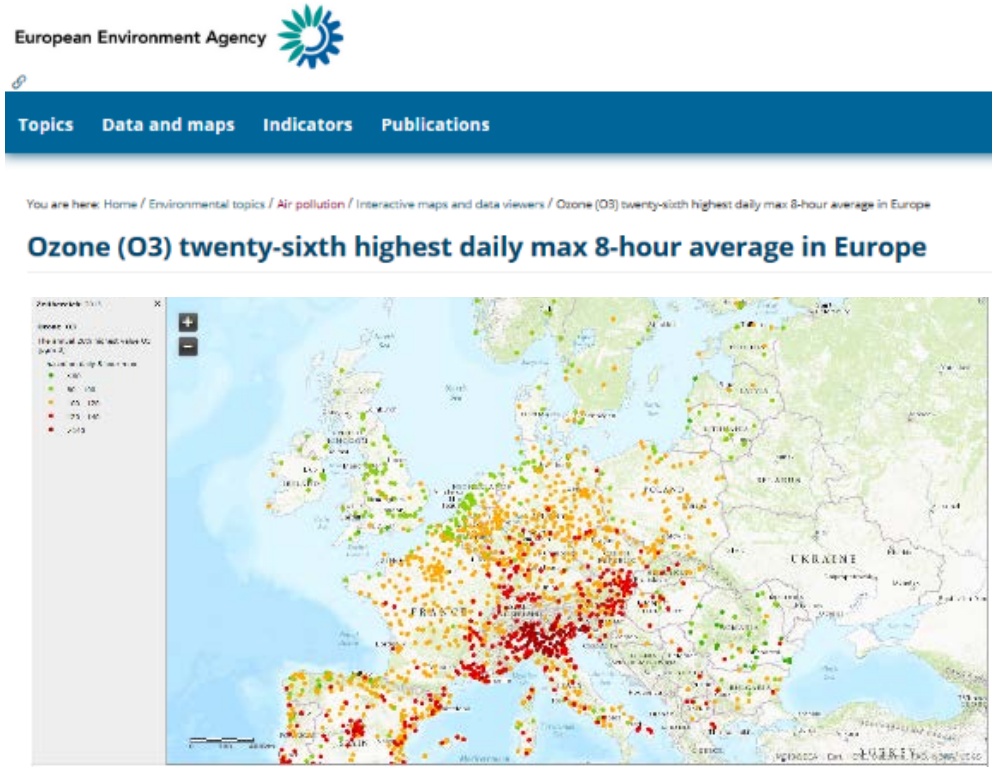
- **Thermal comfort, daylight requirements and internal air quality in the EU (New buildings, 2016)**
- **Will be part of the upcoming EU Building Stock observatory. Any updated info is welcome!**
  - green: requirements place,
  - red: no requirements,
  - grey: data not yet available

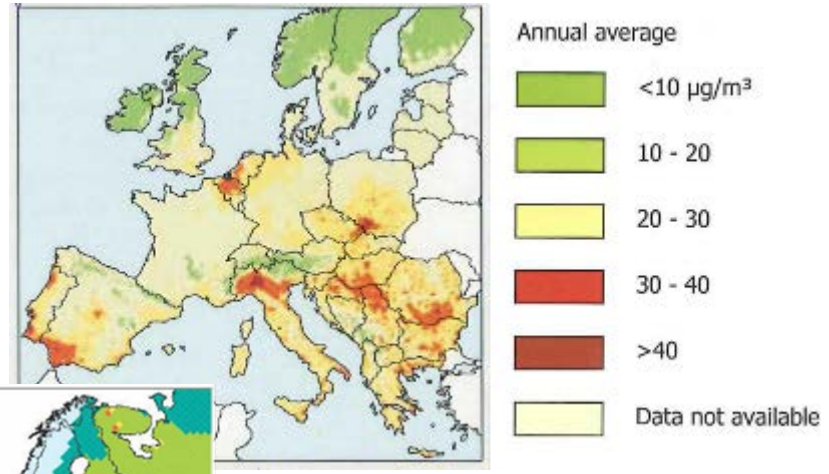


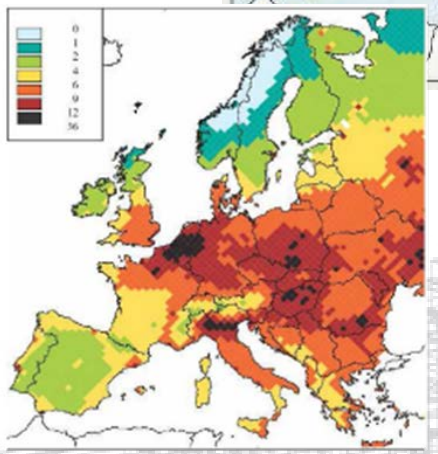
Laurent Deleersnyder
Directorate-General for Energy
Energy Efficiency
EPBD review
EVIA Seminar 11 May 2016, Brussels

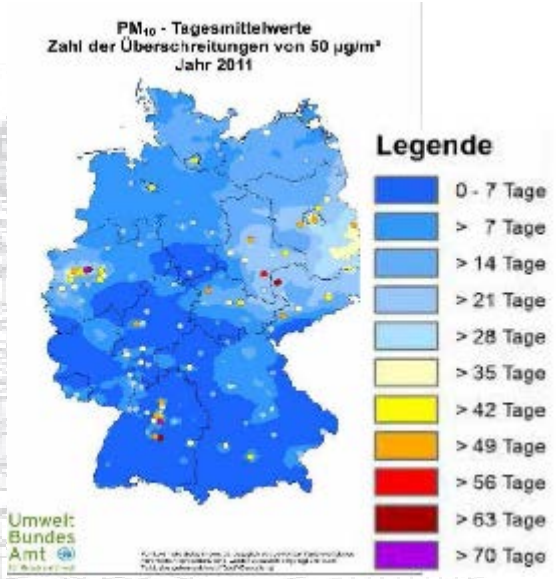
Is Outdoor Air the Benchmark?

- **Yes and No**
  Depending from the location
- **Ventilation systems can consider**





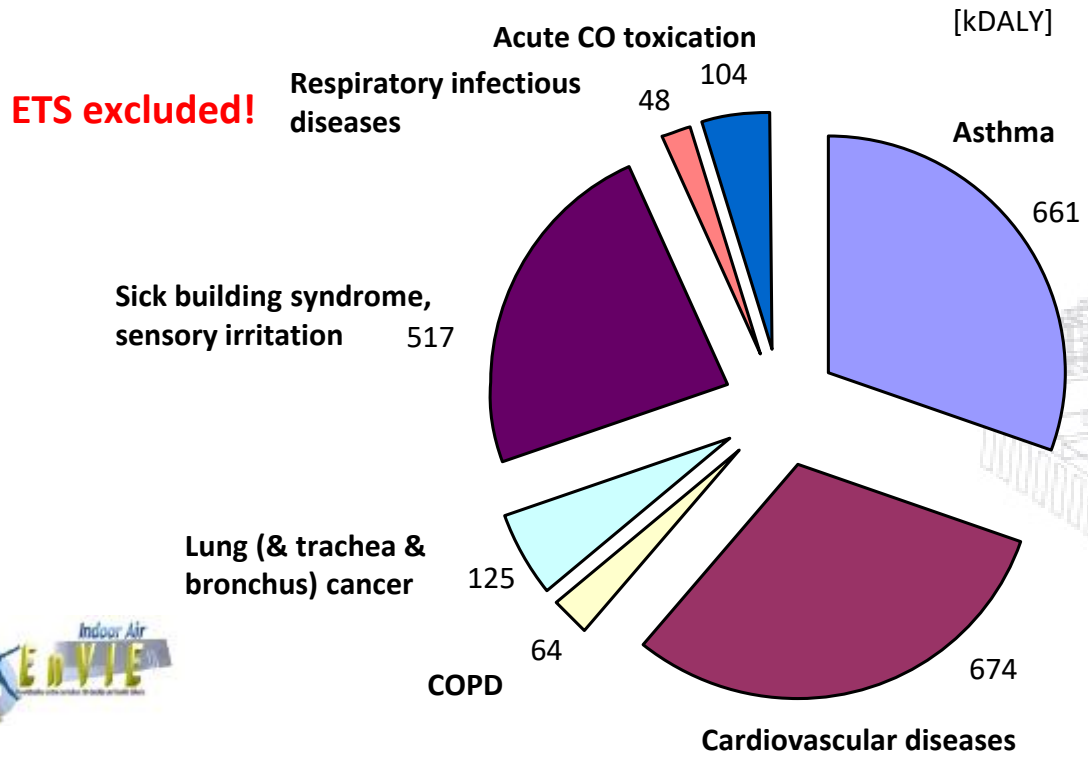


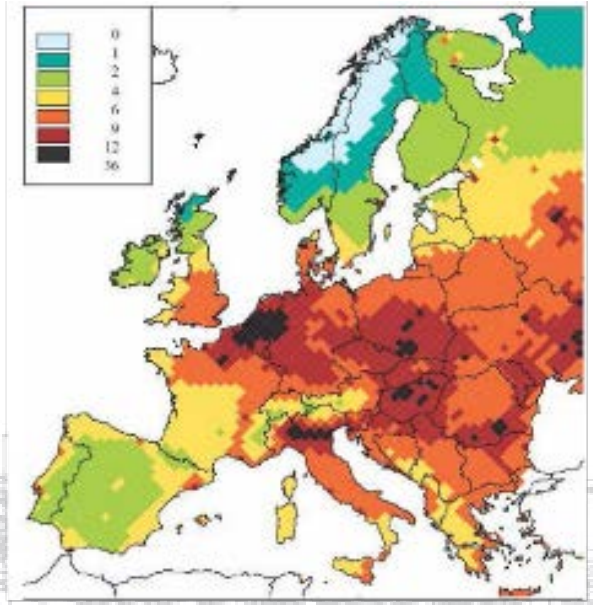


Decreased life expectancy in months due to exposure to fine particulate matter in Europe; Annual emissions 2000
For years, the fine dust values in Germany have not declined but merely reflect climatic or annual deviations.

Ventilation and Fine Dust

- **Burden of disease by disease from compromised IAQ in Europe (EU-27) in 1000 DALYs**
  (Disability adjusted life years) from EnVIE project www.iaq-envie.eu





Decreased life expectancy in months due to exposure to fine particulate matter in Europe; Annual emissions 2000
For years, the fine dust values in Germany have not declined but merely reflect climatic or annual deviations.

*Olliviera Fernandes et al. Health Effects of indoor air quality… **REHVA Journal** 4/2009 pp 13-17*

EN 16798-3 – Aspects of Outdoor Air -> Supply Air

Classification of outdoor air (ODA)

Category	Description	Recommendation
ODA 1	Outdoor air which may be only temporarily dusty (e.g. pollen)	WHO 2005 and other regulatation are fulfilled
ODA 2	Outdoor air with high concentrations of particulate matter and/or gaseous pollutants	WHO 2005 .. by a factor of up to 1,5.
ODA 3	Outdoor air with very high concentrations of gaseous pollutants and/or particulate matter	WHO 2005 .. by a factor of greater then 2.

Classification of supply air (SUP)

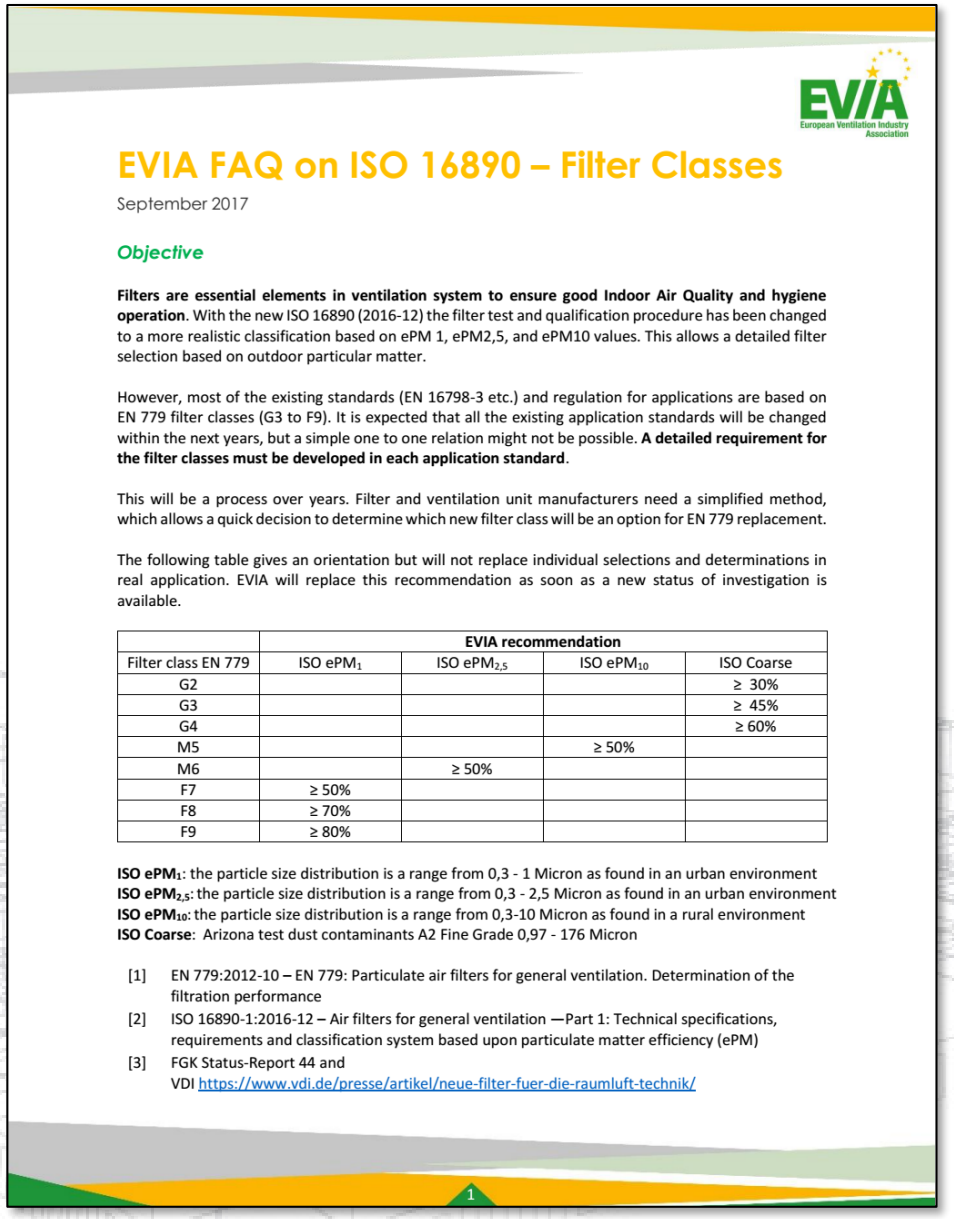
Category	Description	Recommendation
SUP 1	Supply air with very low concentration of particulate matter and/or gases	WHO 2005 .. by a factor of up to 0,25
SUP 2	Supply air with low concentrations of particulate matter and/or gases	WHO 2005 .. by a factor of up to 0,50
SUP 3	Supply air with medium concentrations of particulate matter and/or gases matter	WHO 2005 .. by a factor of up to 0,75
SUP 4	Supply air with high concentrations of particulate matter and/or gases matter	WHO 2005 and other regulatation are fulfilled
SUP 5	Supply air with very high concentrations of particulate matter and/or gases matter	WHO 2005 .. by a factor of up to 1,5.

EN 16798-3 – Aspects of Outdoor Air -> Supply Air

- **Recommended minimum filter classes per filter section (definition of filter classes according to EN 779)**

Outdoor air quality	Supply air quality				
	SUP 1	SUP 2	SUP 3	SUP 4	SUP 5
ODA 1	M5+F7	F7	F7	F7	-
ODA 2	F7 + F7	M5 + F7	F7	F7	M5
ODA 3	F7 + F9	F7 + F7	M6 + F7	F7	F7

- **Update on ISO 16798 is ongoing**
- **Detailed specification of filters is possible based on**
  - PM_1 no limits, few measurement stations
  - $PM_{2,5}$
  - PM_{10}



EVIA

European Ventilation Industry Association

EVIA FAQ on ISO 16890 – Filter Classes

September 2017

Objective

Filters are essential elements in ventilation system to ensure good Indoor Air Quality and hygiene operation. With the new ISO 16890 (2016-12) the filter test and qualification procedure has been changed to a more realistic classification based on ePM 1, ePM2,5, and ePM10 values. This allows a detailed filter selection based on outdoor particular matter.

However, most of the existing standards (EN 16798-3 etc.) and regulation for applications are based on EN 779 filter classes (G3 to F9). It is expected that all the existing application standards will be changed within the next years, but a simple one to one relation might not be possible. **A detailed requirement for the filter classes must be developed in each application standard**.

This will be a process over years. Filter and ventilation unit manufacturers need a simplified method, which allows a quick decision to determine which new filter class will be an option for EN 779 replacement.

The following table gives an orientation but will not replace individual selections and determinations in real application. EVIA will replace this recommendation as soon as a new status of investigation is available.

	EVIA recommendation			
Filter class EN 779	ISO ePM_1	ISO $ePM_{2,5}$	ISO ePM_{10}	ISO Coarse
G2				≥ 30%
G3				≥ 45%
G4				≥ 60%
M5			≥ 50%	
M6		≥ 50%		
F7	≥ 50%			
F8	≥ 70%			
F9	≥ 80%			

ISO ePM_1: the particle size distribution is a range from 0,3 - 1 Micron as found in an urban environment
ISO $ePM_{2,5}$: the particle size distribution is a range from 0,3 - 2,5 Micron as found in an urban environment
ISO ePM_{10}: the particle size distribution is a range from 0,3-10 Micron as found in a rural environment
ISO Coarse: Arizona test dust contaminants A2 Fine Grade 0,97 - 176 Micron

[1] EN 779:2012-10 – EN 779: Particulate air filters for general ventilation. Determination of the filtration performance
[2] ISO 16890-1:2016-12 – Air filters for general ventilation —Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)
[3] FGK Status-Report 44 and VDI https://www.vdi.de/presse/artikel/neue-filter-fuer-die-raumluft-technik/

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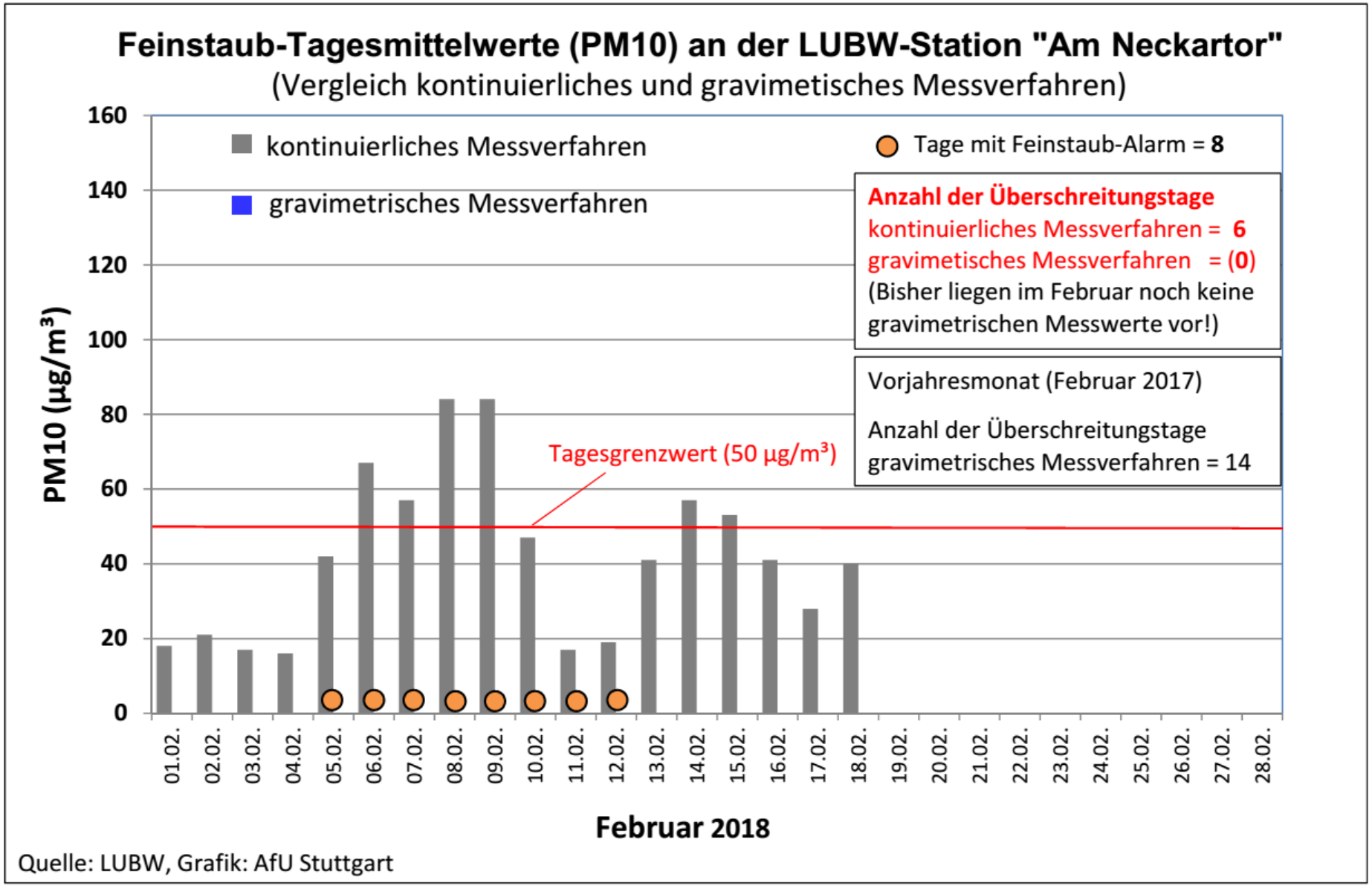
Feinstaub-Tagesmittelwerte (PM10) an der LUBW-Station "Am Neckartor"
(Vergleich kontinuierliches und gravimetisches Messverfahren)
kontinuierliches Messverfahren
gravimetrisches Messverfahren
Tage mit Feinstaub-Alarm = 8
Anzahl der Überschreitungstage
kontinuierliches Messverfahren = 6
gravimetisches Messverfahren = (0)
(Bisher liegen im Februar noch keine gravimetrischen Messwerte vor!)
Vorjahresmonat (Februar 2017)
Anzahl der Überschreitungstage
gravimetrisches Messverfahren = 14
Tagesgrenzwert (50 µg/m³)
PM10 (µg/m³)
160
140
120
100
80
60
40
20
0
01.02.
02.02.
03.02.
04.02.
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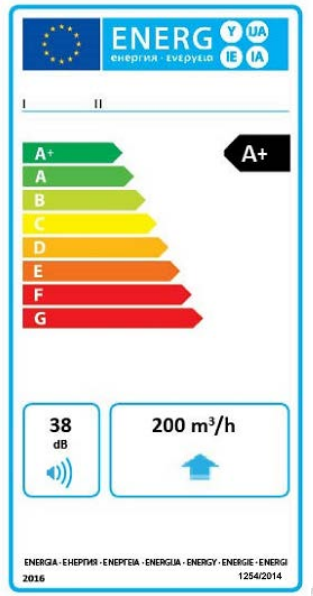
Februar 2018
Quelle: LUBW, Grafik: AfU Stuttgart

Energy Labelling Residential Ventilation - Regulatory Perspective

Ecodesign and Energy Labelling EU 1254/2014

- No minimum requirements on IAQ Performance
- No information for required ventilation rates
- No information on filtration
- No information on DCV



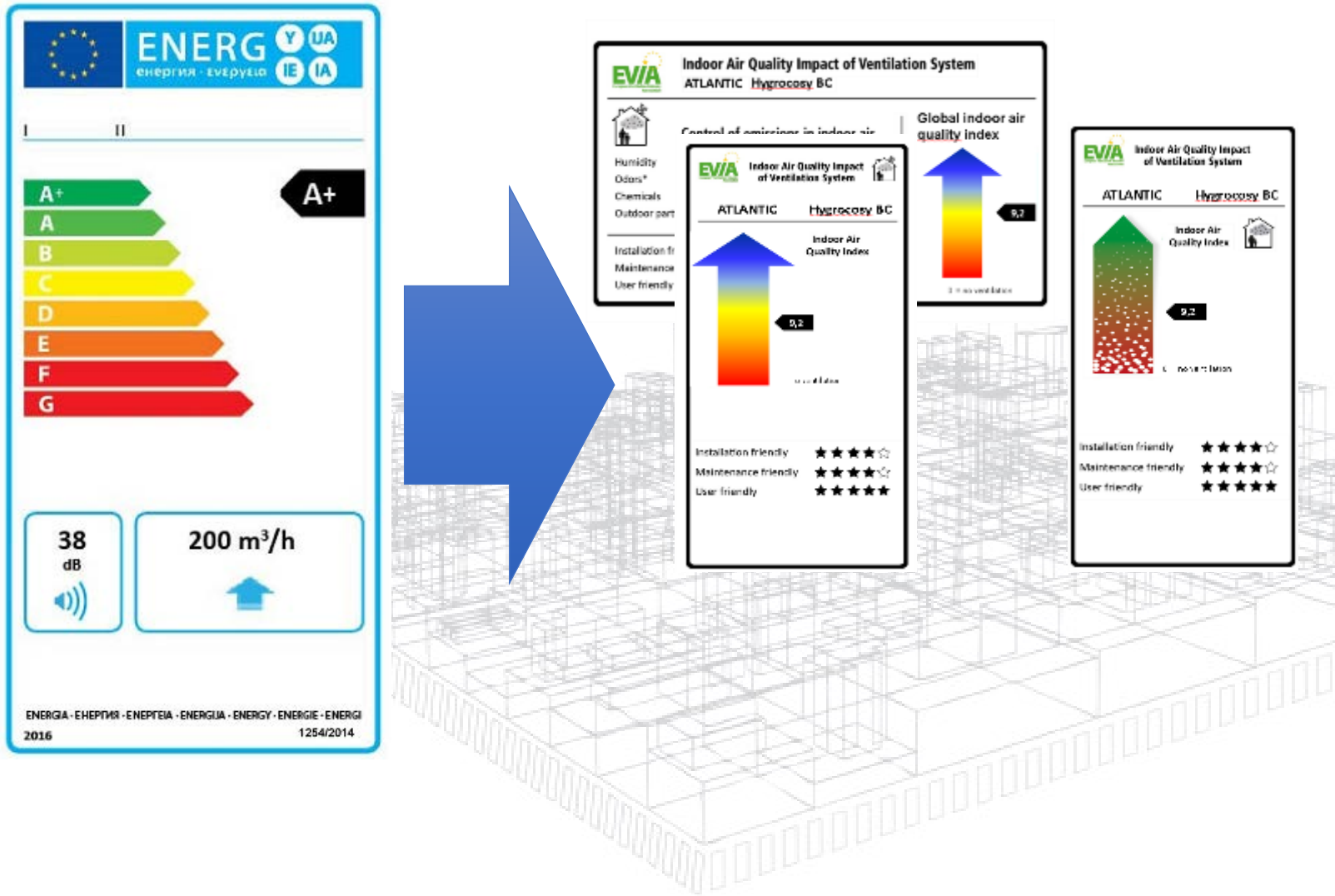
Construction products directive EU 305/2011

- No minimum requirements and no classification

- ☒ Ventilation rate
- ☒ Moisture removal
- ☒ Winter Comfort
- ☒ Particle removal
- ☒ VOC and Odours removal
- ☒ CO_2 level

Currently in ErP Label:
No Indicator in Energy Labelling von Ventilation Units

- **Moisture removal**
- **Winter Comfort**
- **Particle removal**
- **VOC and Odours removal**
- **CO_2 level**



How to adress IAQ outside of regulation

- **My Health My Home**
  www.myhealthmyhome.com
  A Long Term Indoor Air Quality Campaign

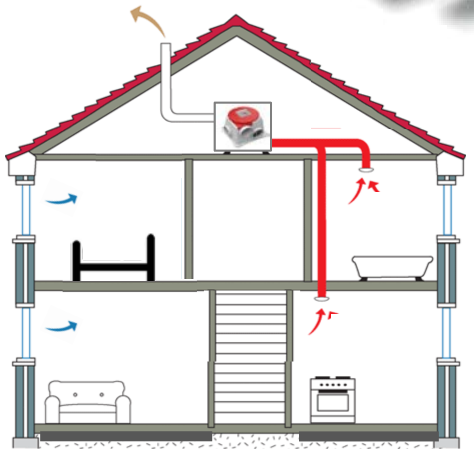
- **“Hygiene in der Wohnungslüftung”**
  www.hygiene-wohnungslueftung.de
  Information how to get a hygiene ventilation system
  - Design, Installation, Maintenance
  - User, Installer, Manufacturer

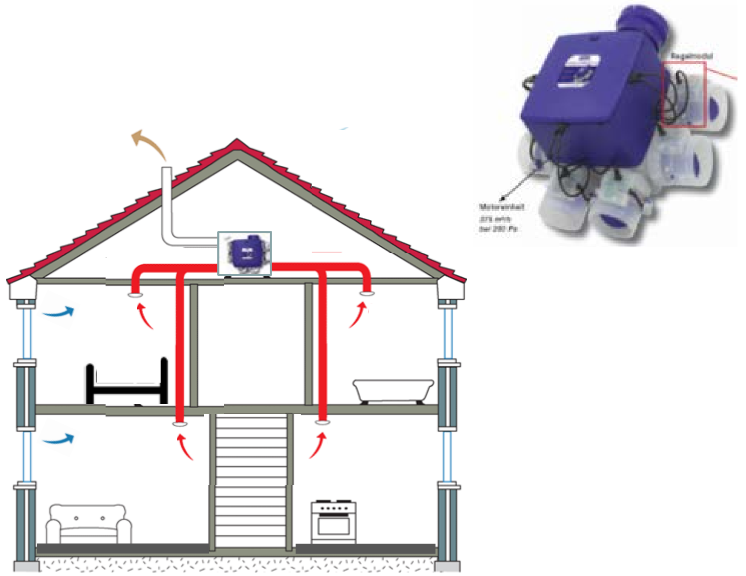
- **EVIA IAQ campaign**

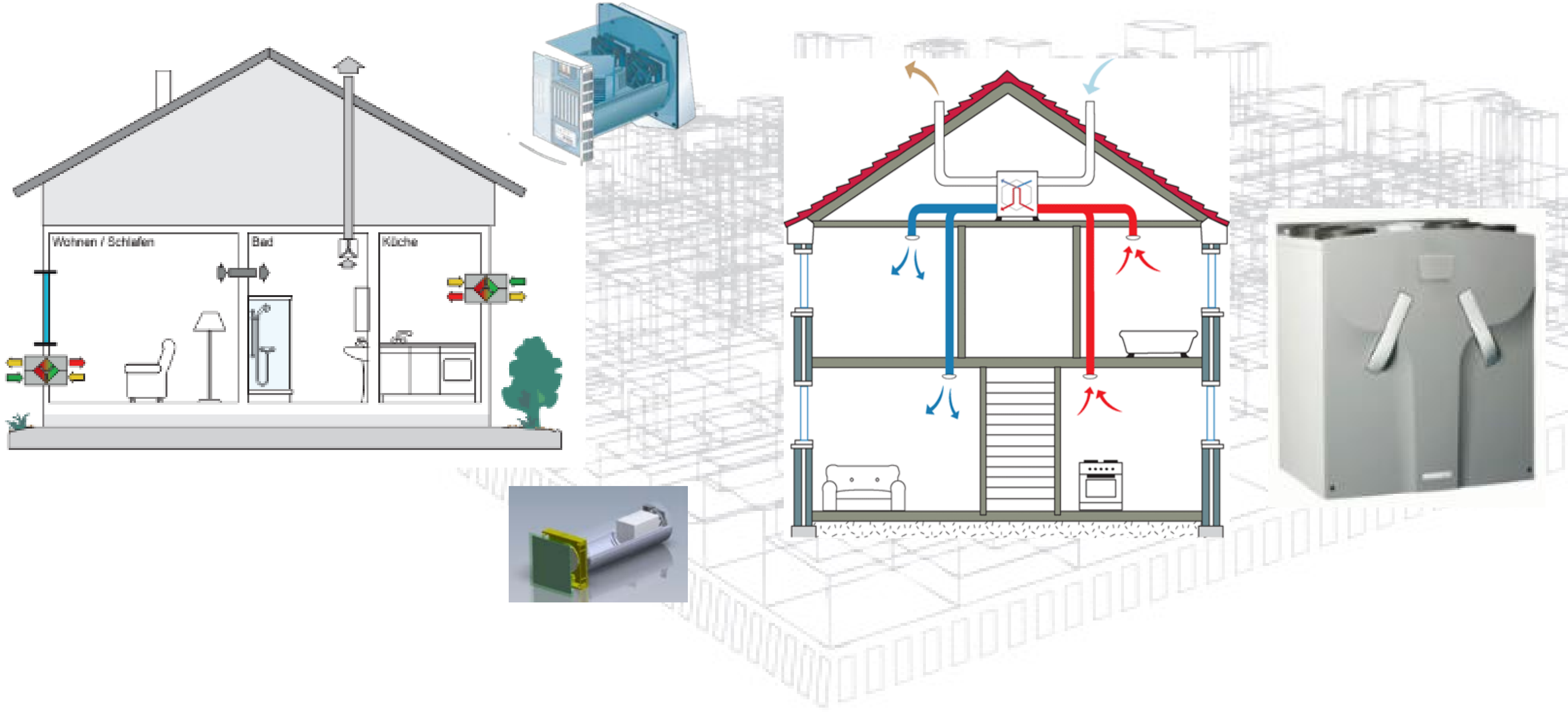
Fachverband Gebäude-Klima e.V

Technology for IAQ in Residential

- Technologies for the building stock
- Technologies for new buildings
- Demand-control systems
  - Smart Systems
- Local systems
- Multi-functional systems

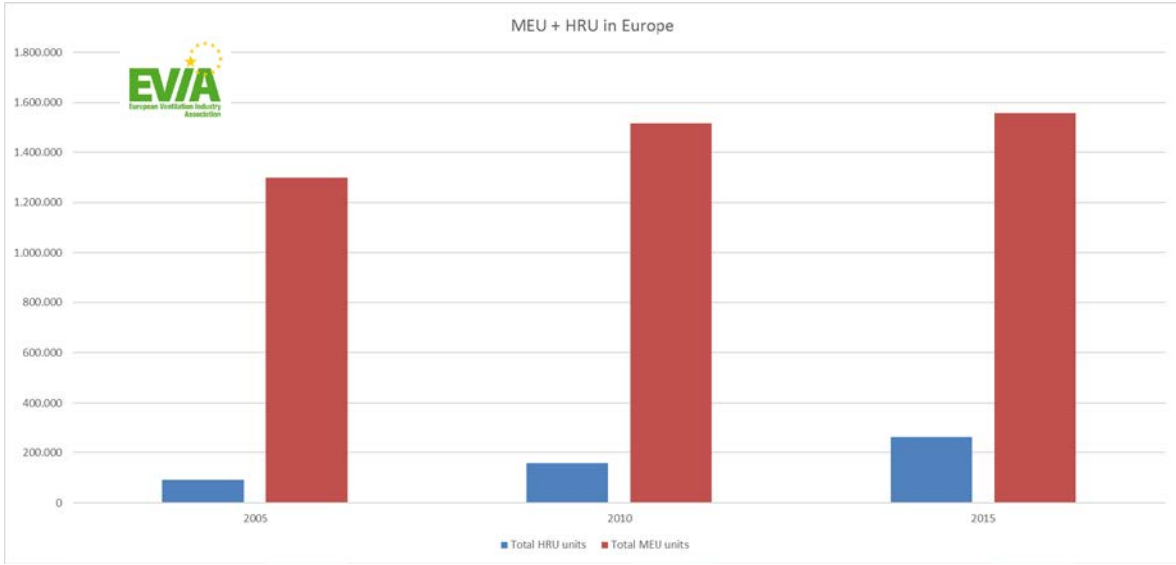




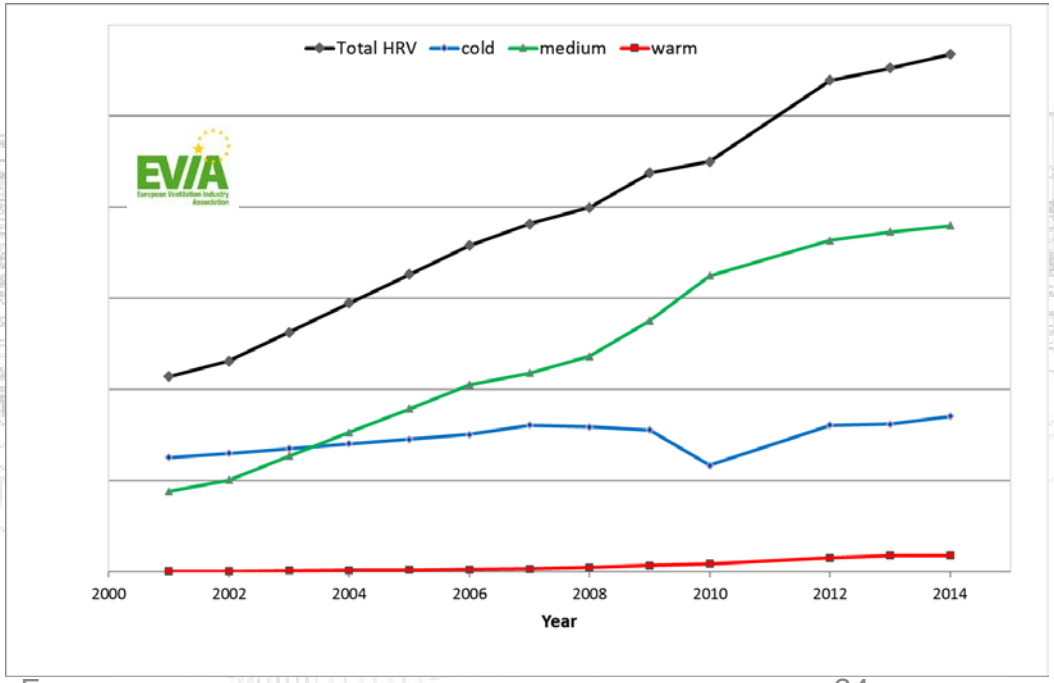


Residential Ventilation Market

- Growing market
- Mechanical Extract Units are dominating in Europe



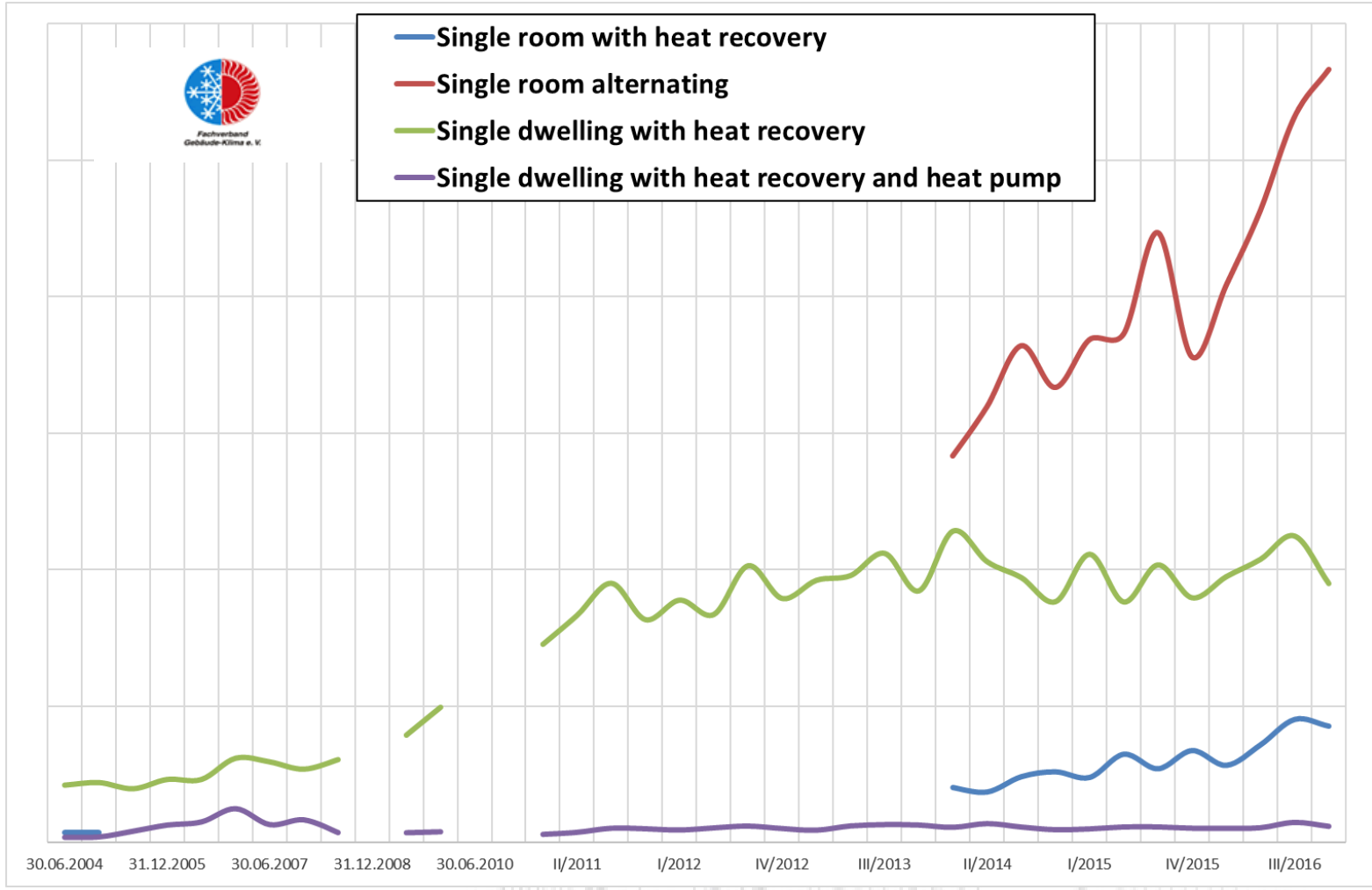
- Ventilation units with heat recovery
- Growing market
- Developed market in cold climates
- Growing market in medium climates
- No significant data in warm climates
- Cold / enthalpy recovery?



Trend residential units with heat recovery in Germany

- **Single dwelling units:**
  - Strong growing until 2012
  - Stable / light growing since 2013
- **Single room units:**
  - Strong growing
- **No data on exhaust units**

- **Is this just a German issue?**

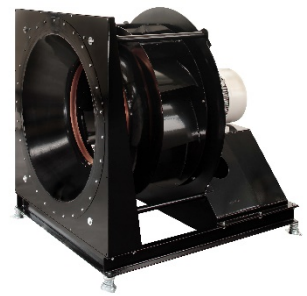


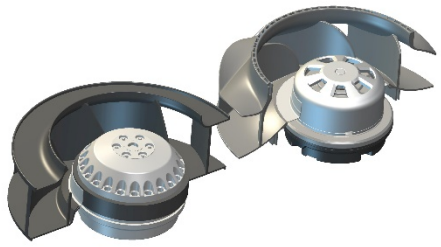
Improoved Indoor Air Quality and Energy Savings

- **Estimated savings based on ErP Regulation in 2020**
- **EU 326/2011 Fans**
- **EU 1253/2014 Ventilaton Units**

- **Better IAQ**
- **Less Energy**

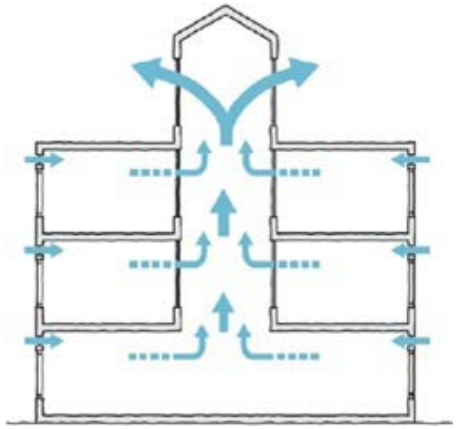
Produt	Endenergy	Primary Energy
Residential Ventilation (Heating)	222 TWh	244 TWh
Ventilation NR – Heating	150 TWh	165 TWh
Ventilation NR – Electricity	16 TWh	40 TWh
Ventilation NR – Cold	8 TWh	8 TWh
Fans – all Applications	34 TWh	82 TWh
Total 2020		**539 TWh**
Demand EU 27		~20.000 TWh
Savings Potential		2-3%

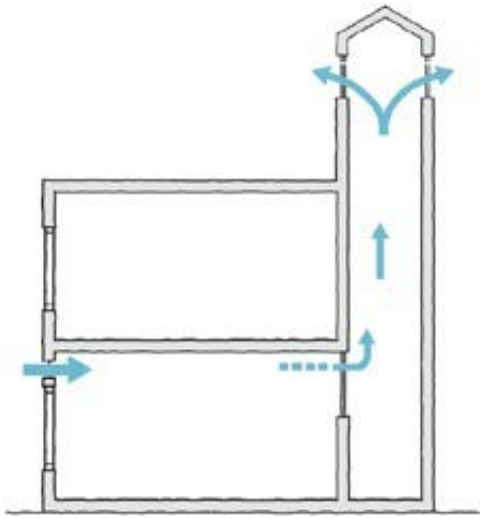


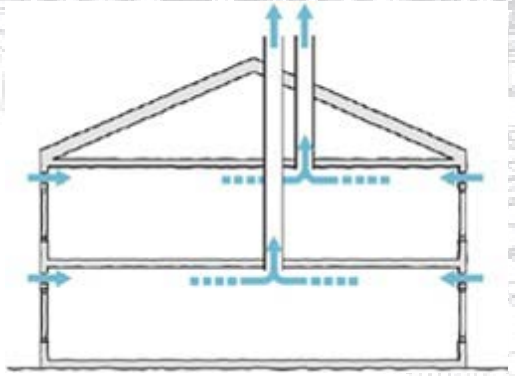


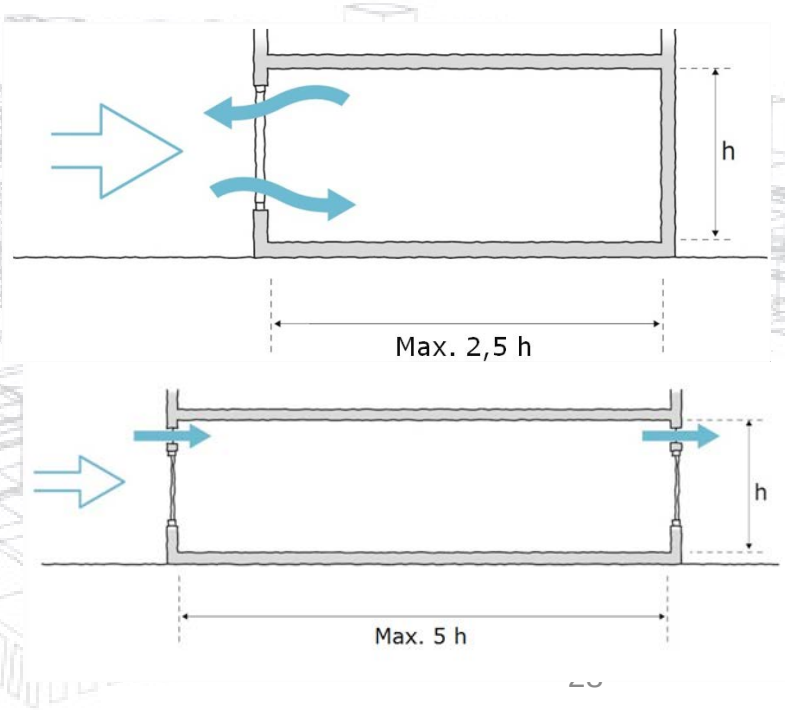
What about natural ventilation and IAQ?

- **Ventilation shall be at the right amount at the right time at the right place.**
  - Difficult with natural systems because:
    - Wind changes
    - Stack changes
  - Demand controlled systems expensive
  - Building
- **Thermal comfort difficult**
  - Draft risk
- **Energy efficiency**
  - Overventilation
  - No Heat recovery
- **Outdoor air quality**
  - No filtration possible









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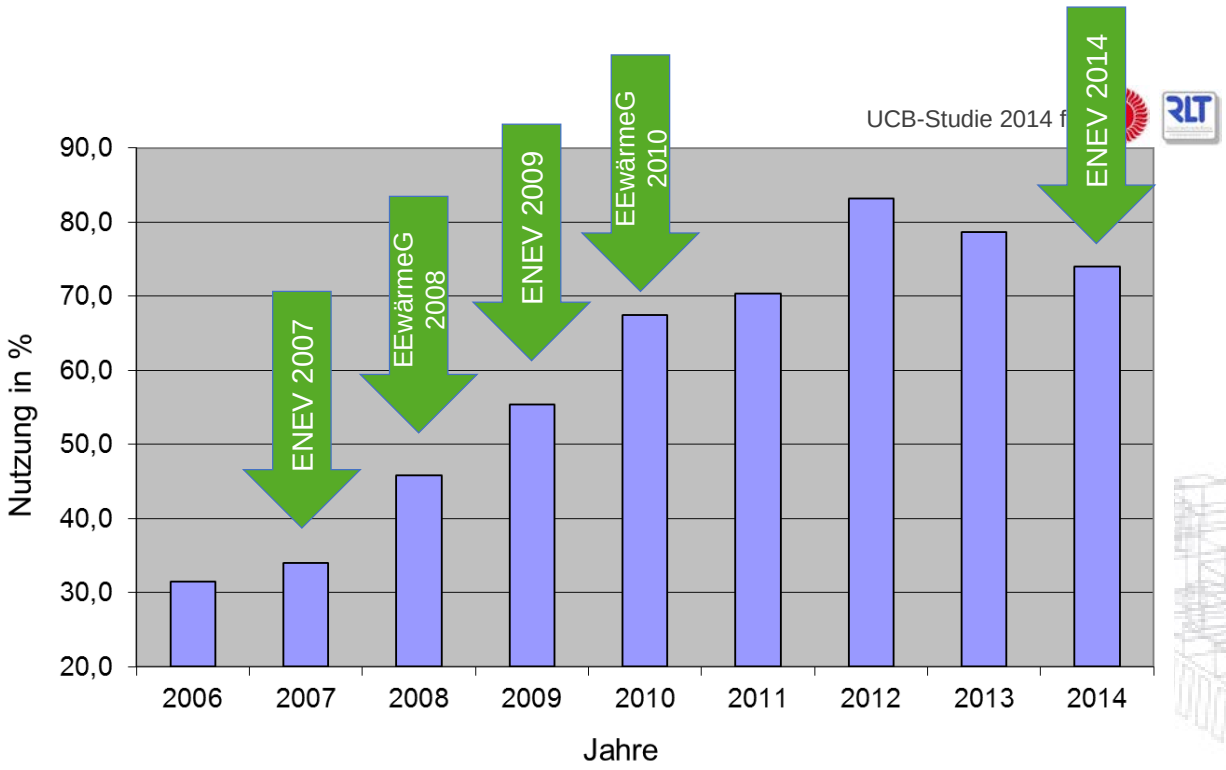
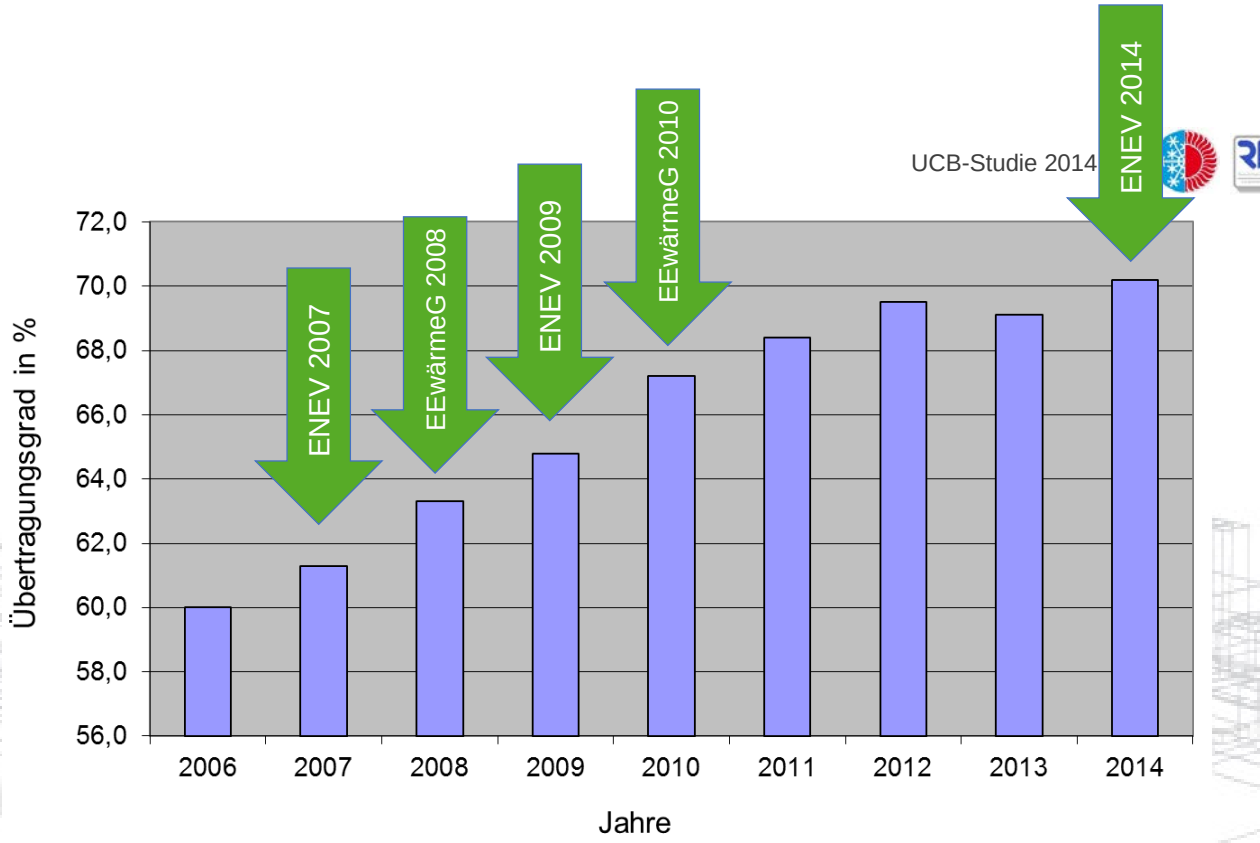
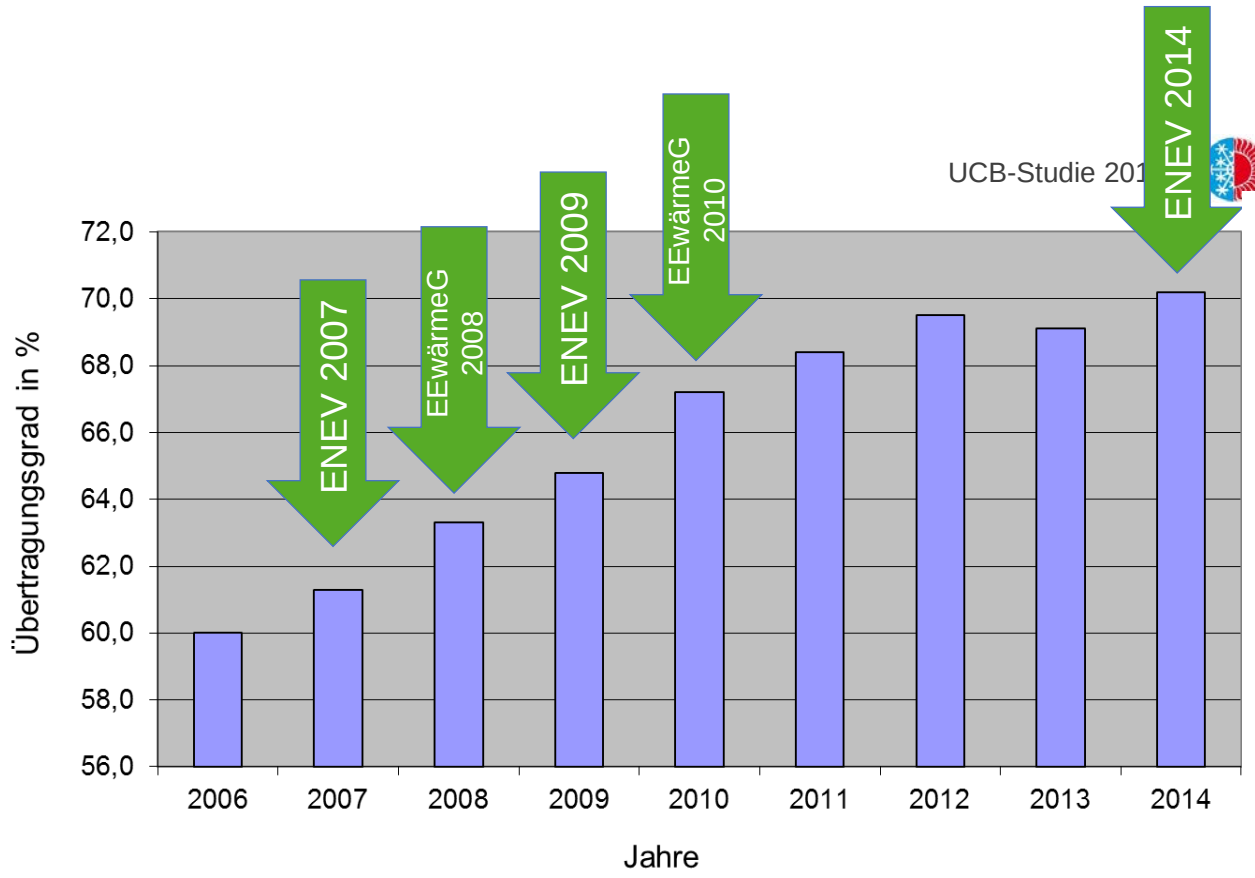
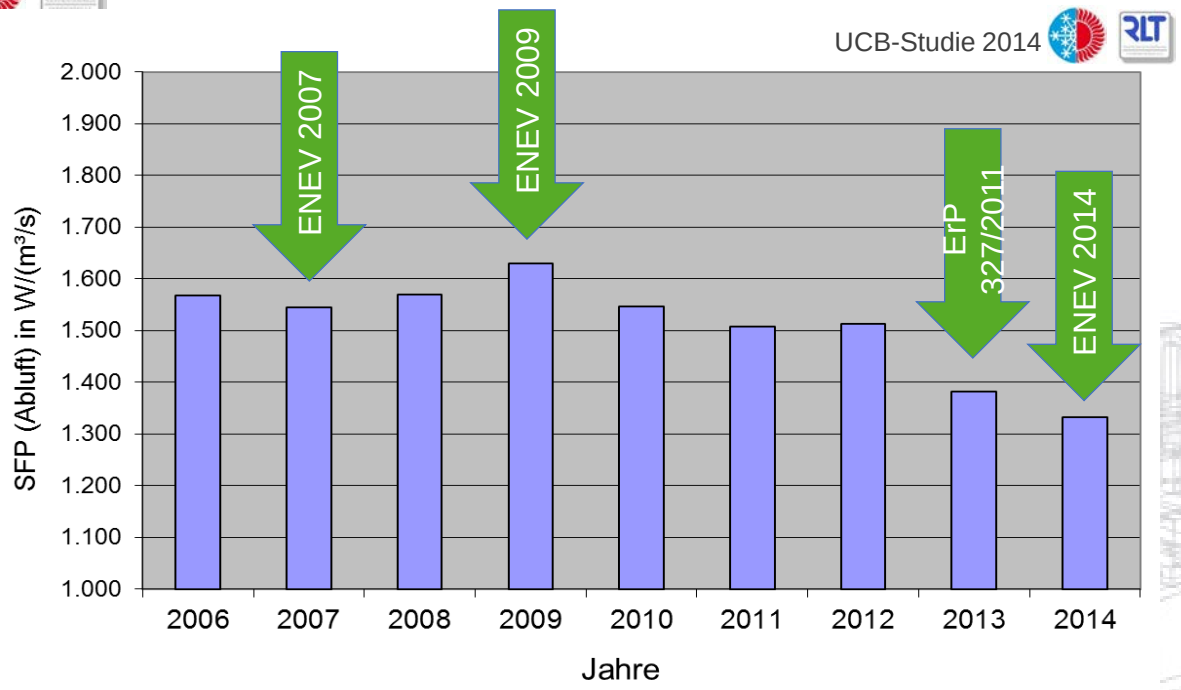
Is Regulation needed?
Deveopment of Heat recovery and Regulation in Germany





Is Regulation needed?
Deveopment of Specific Fan Power and Regulation in Germany





Questions?

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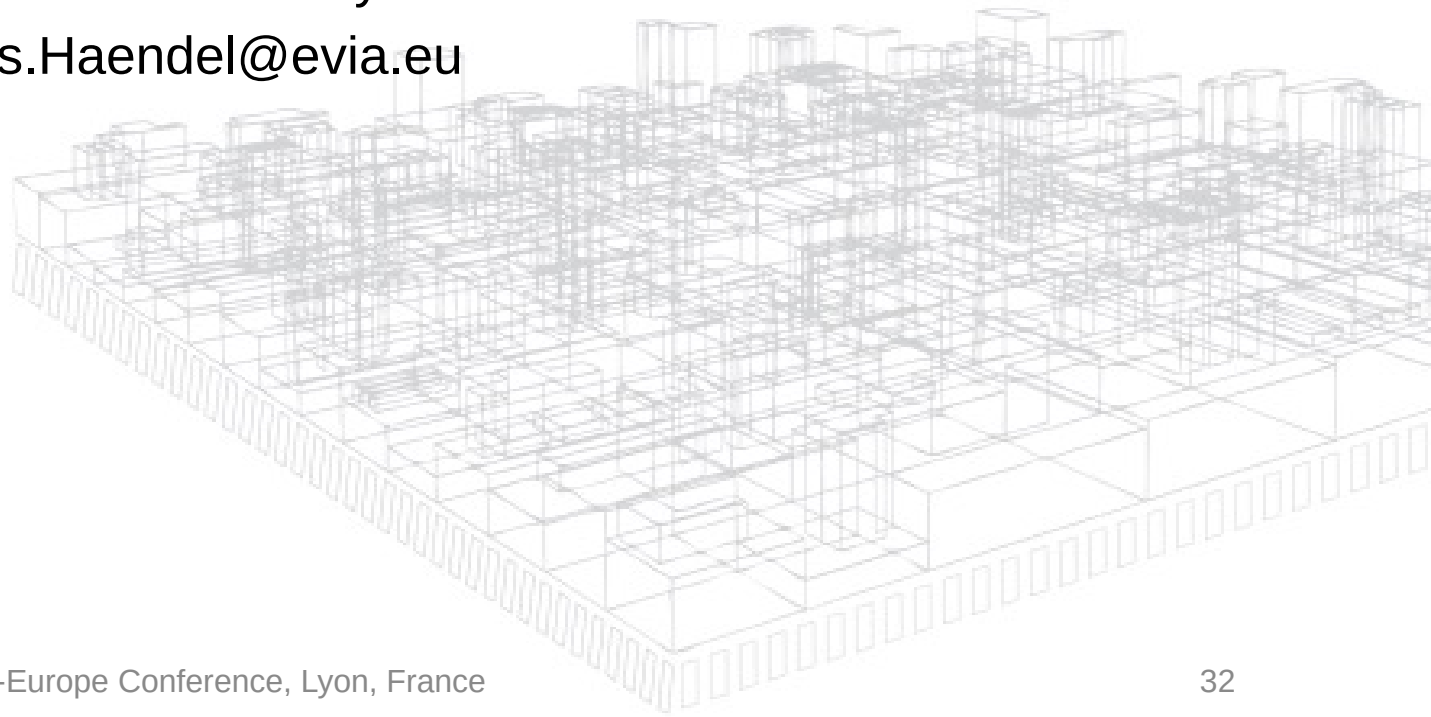
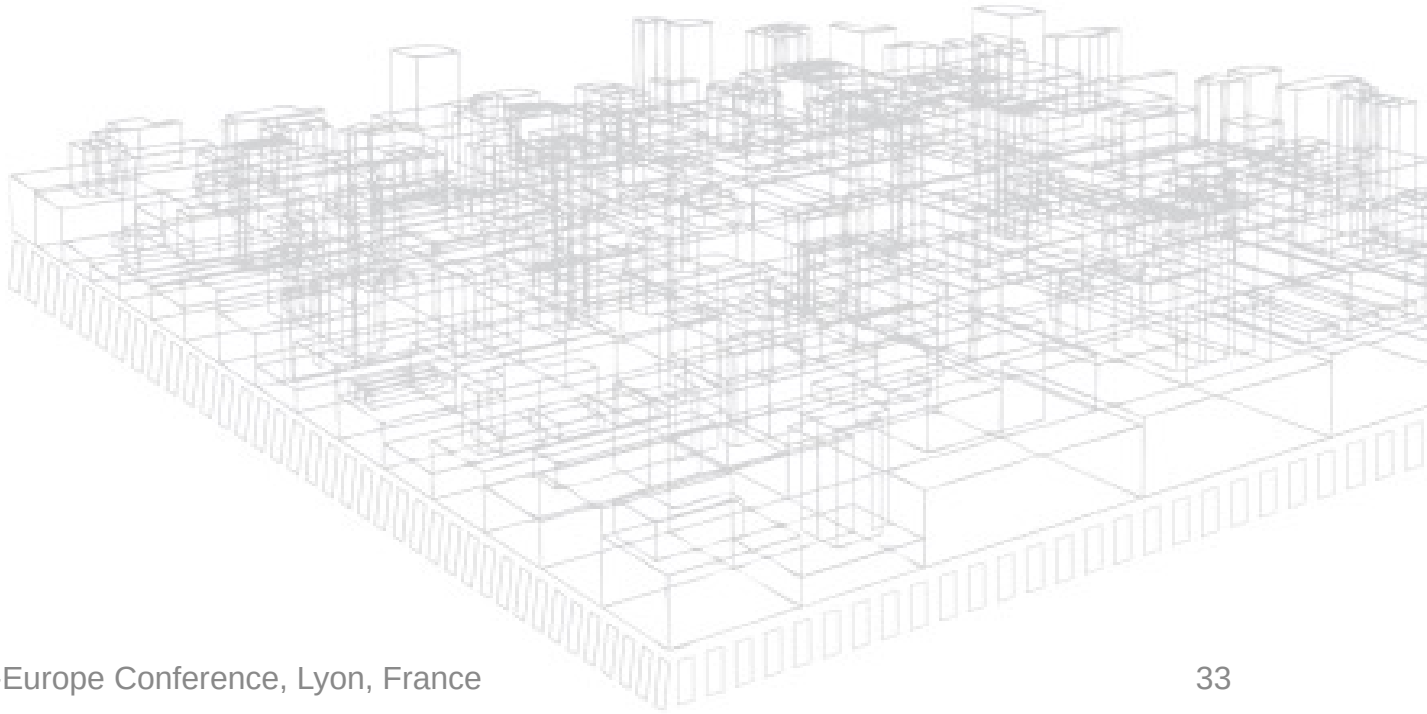


Backup



Energy Inspection of Air Conditioning Systems „Chancen der Energetischen Inspektion“

- **Analysis of Energy Inspections in Germany based on EPBD Article 15**
- **Approx 400,000 AC-Systems > 12kW installed in building stock**
- **Approx 4,300 AC-Systems have been inspected (2007 - 2012)**
- **Execution quote: 1,5 to 2,5% !!**
- **Systems up to 50 years old!**

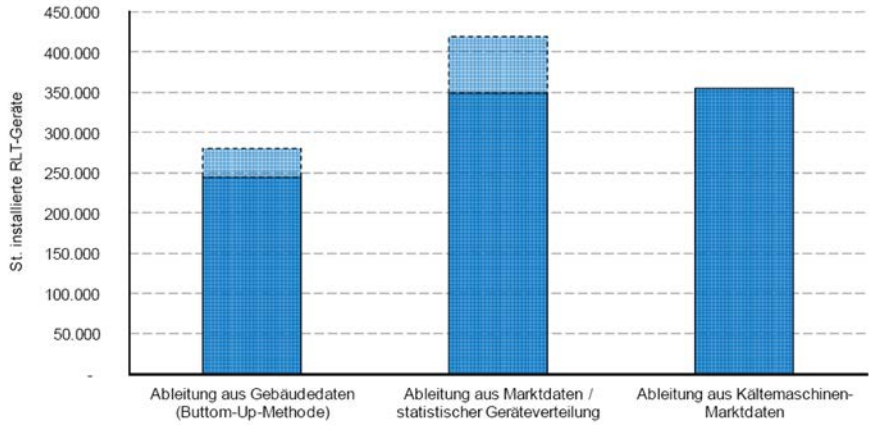
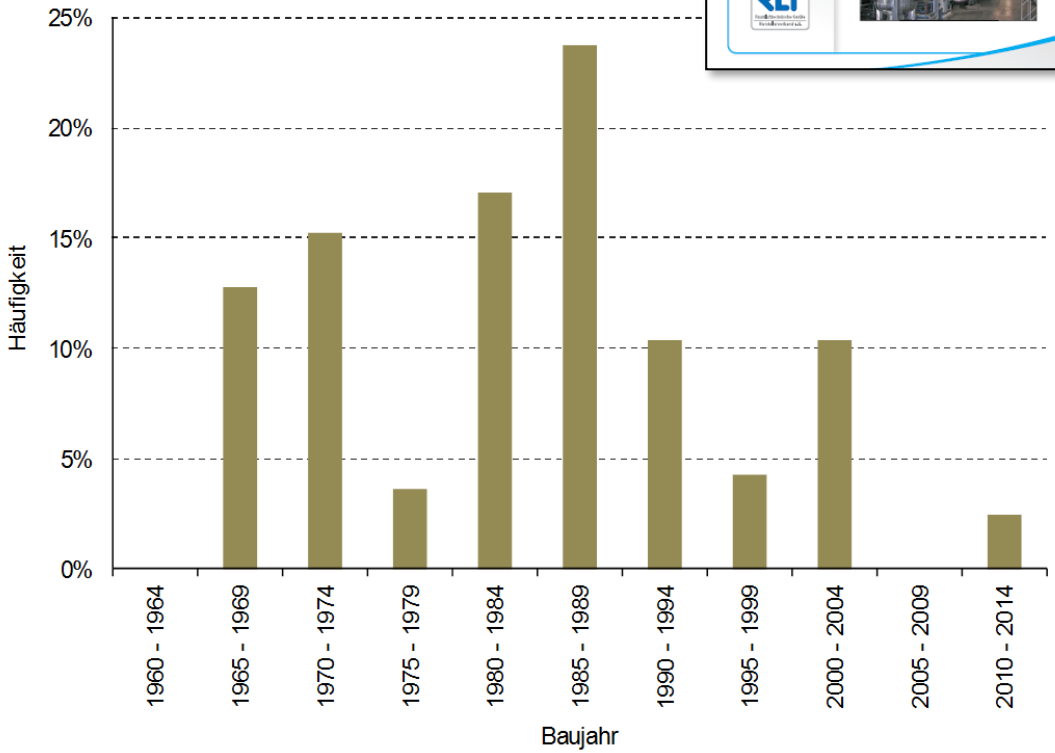
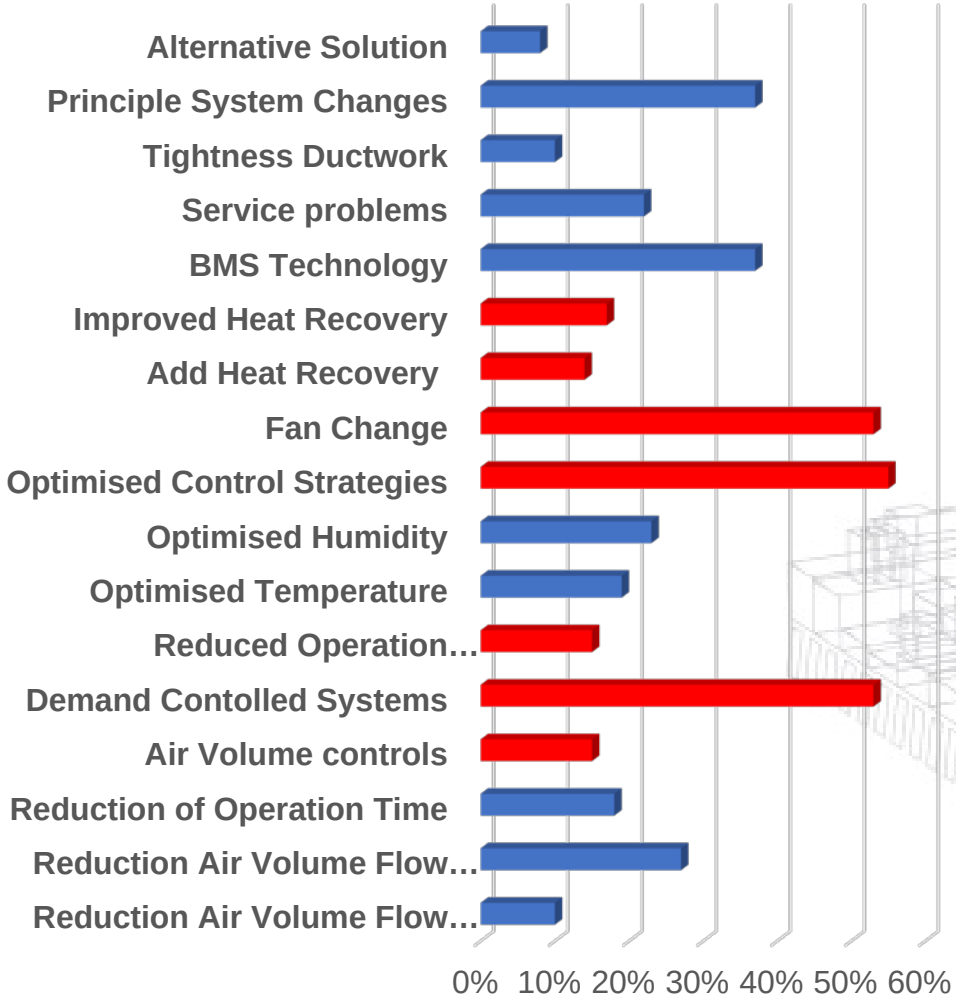


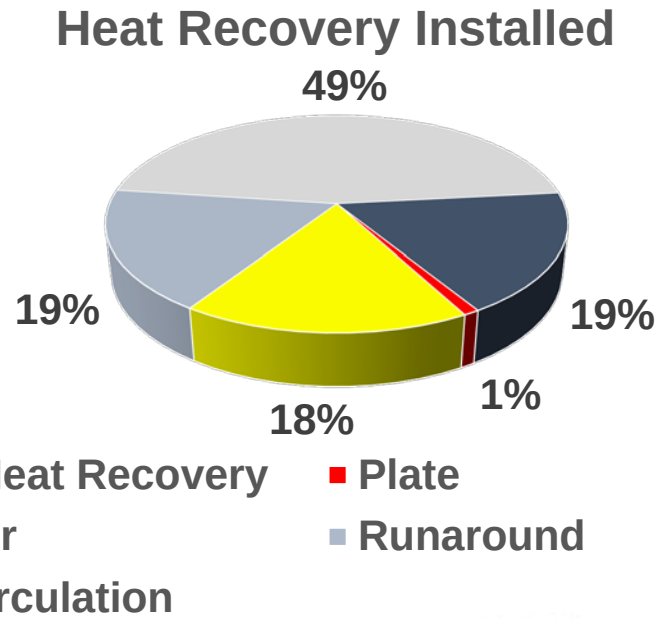
Abbildung 8: Abschätzung der Stückzahlen von installierten RLT-Anlagen für 2012 nach verschiedenen Methoden



Energy Inspection of Air Conditioning Systems „Chancen der Energetischen Inspektion“

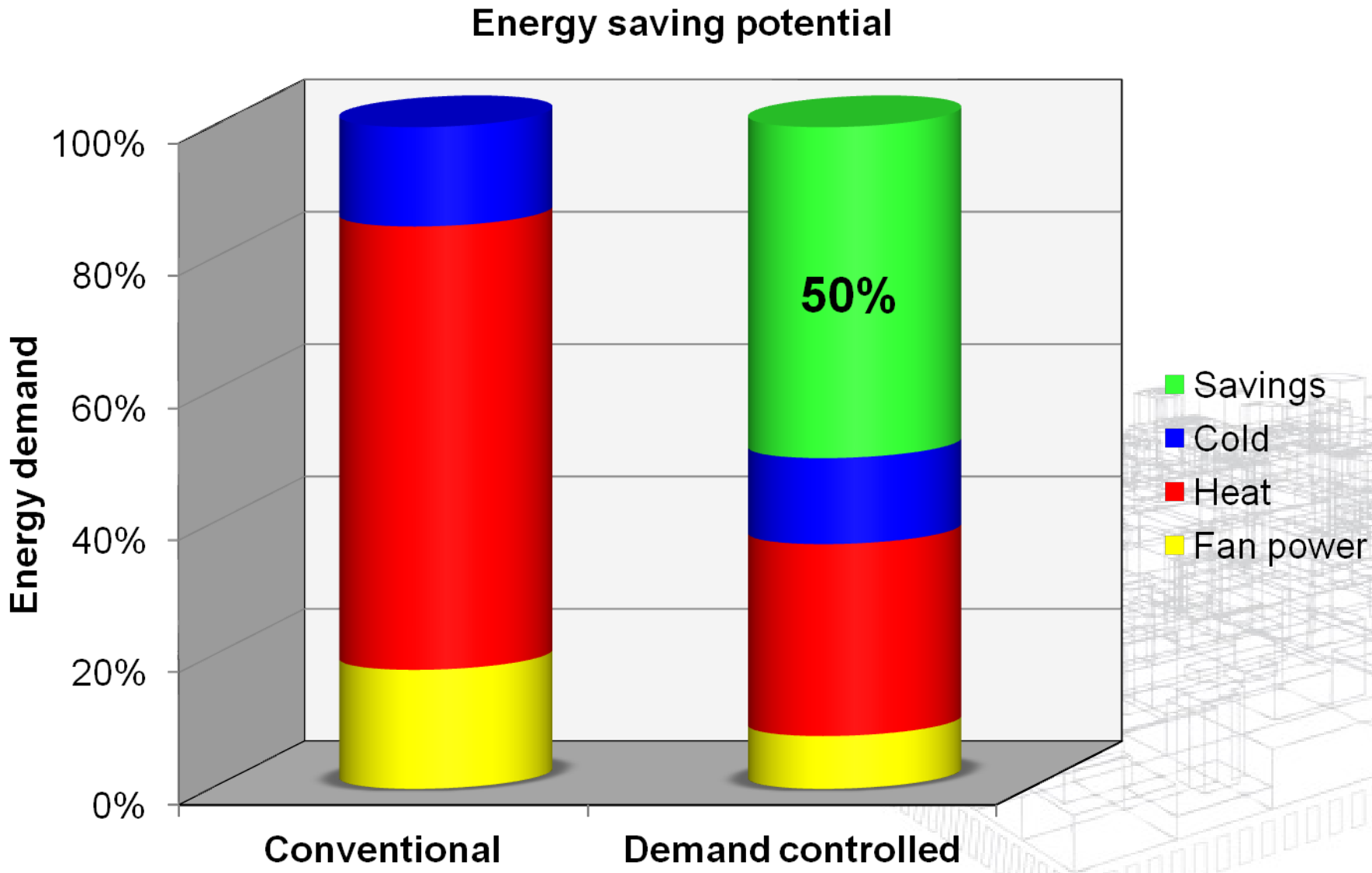
Detected improvements of the systems



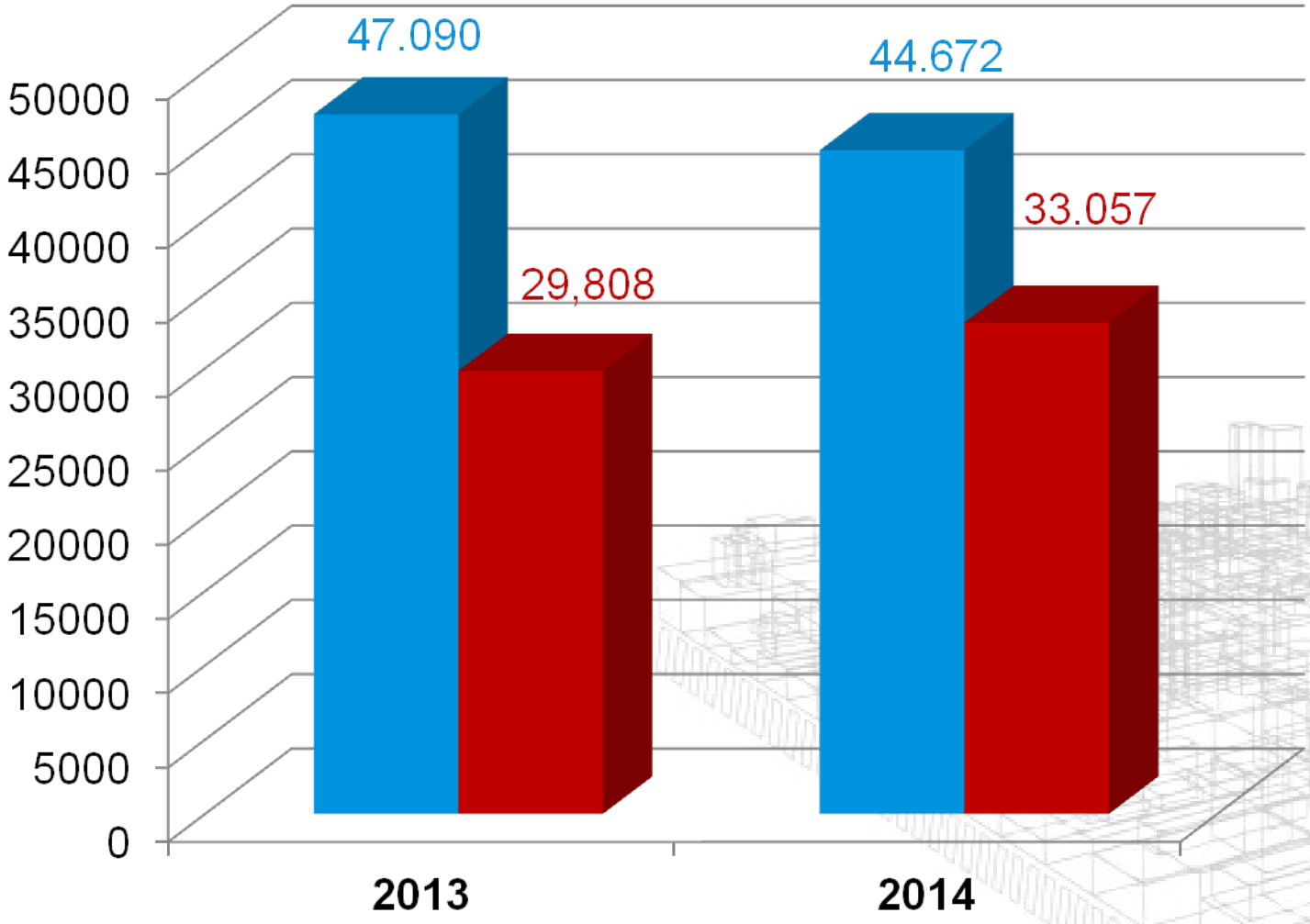


All this is valid also for ventilation only systems
-> Inspections of Ventilation Systems shall be added in EPBD

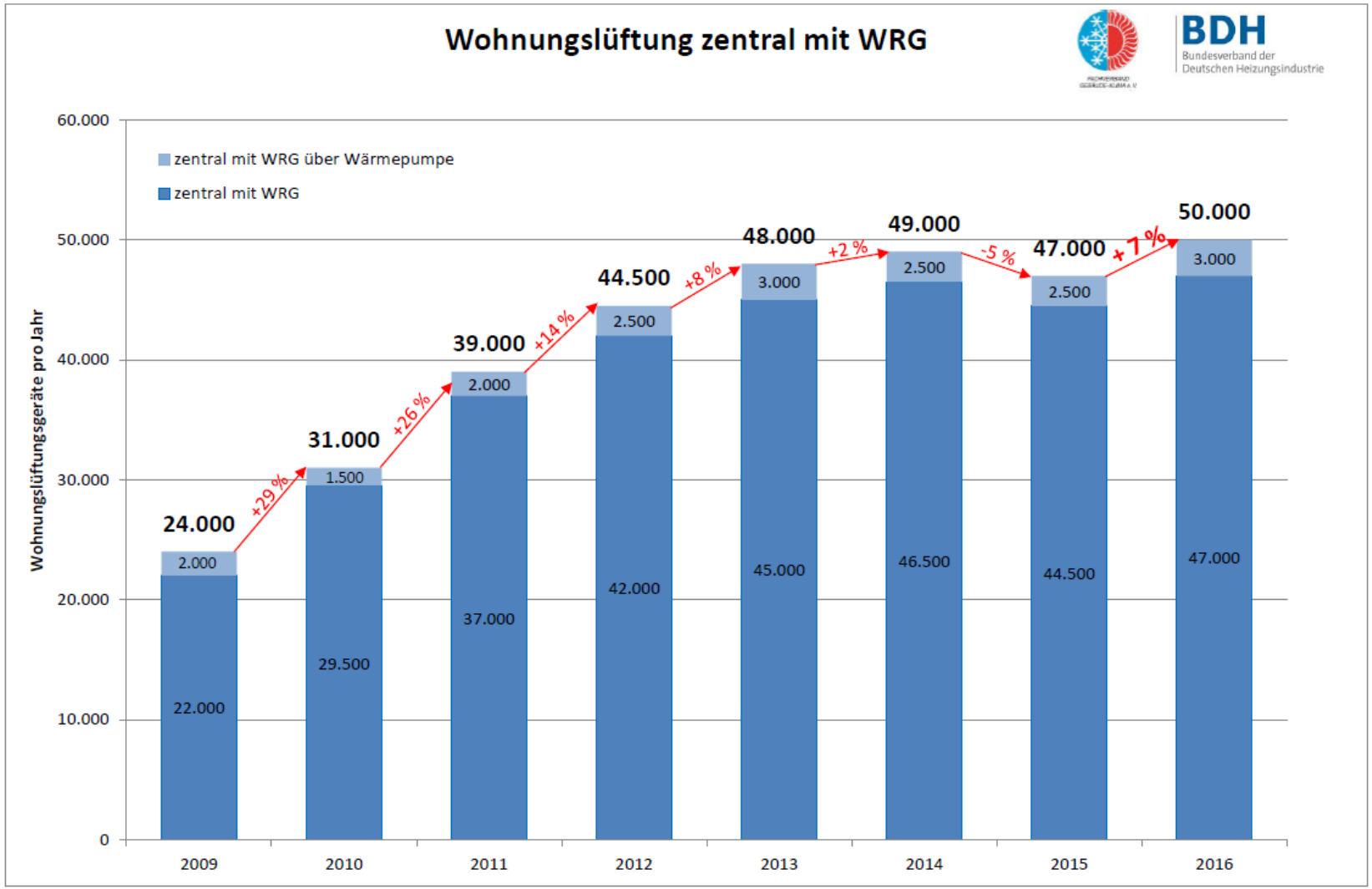
Demand controlled ventilation



Market for Air Handling Units 2013 / 2014



Market development, central systems for residential ventilation



Market development, decentral, roomwise