Healthy Homes Hub

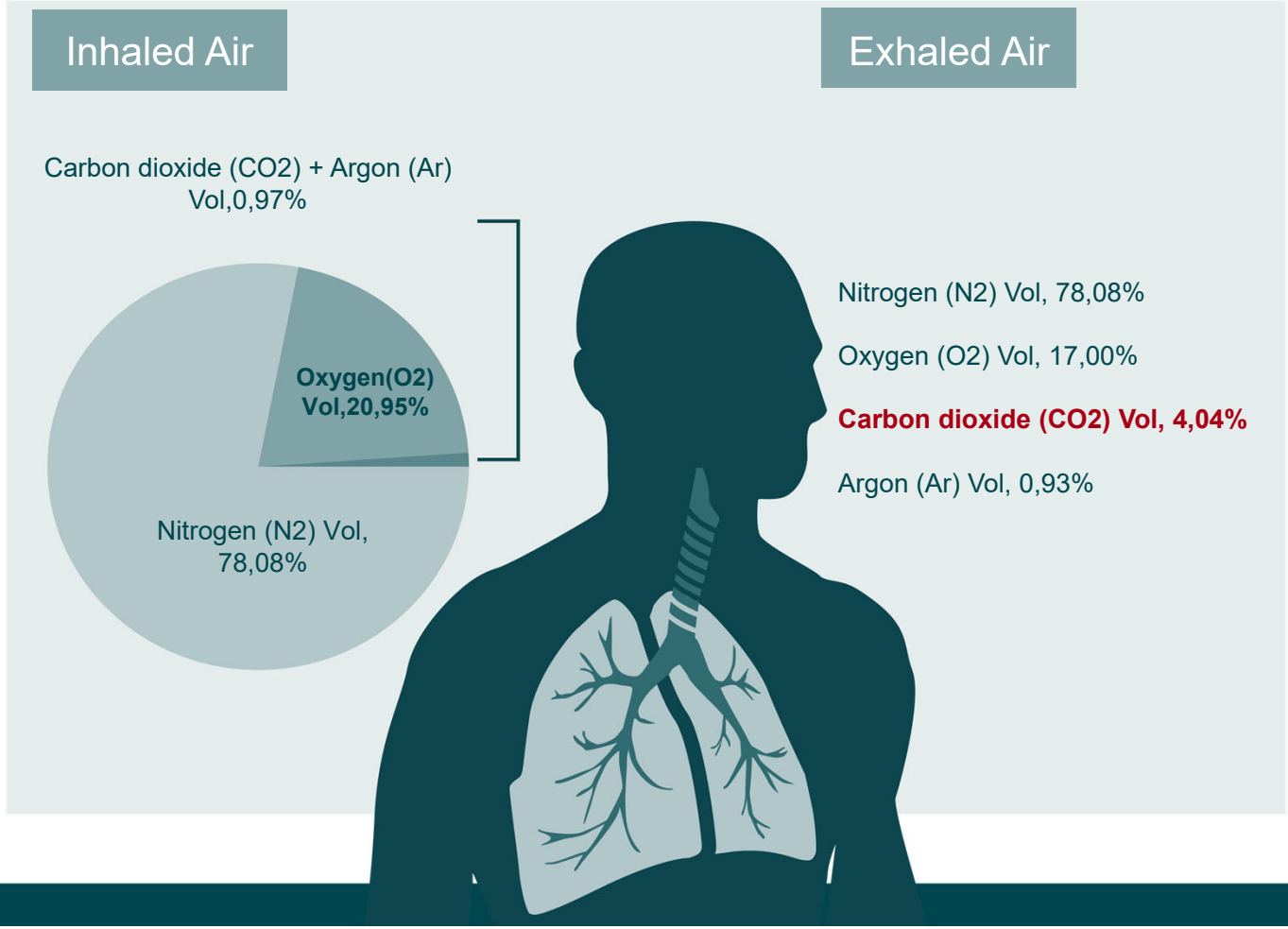
Masterclass #1

Welcome and Introductions

Overview of CPD objectives and schedule

CO_2 of exhaled air is over 100 times bigger than inhaled air…

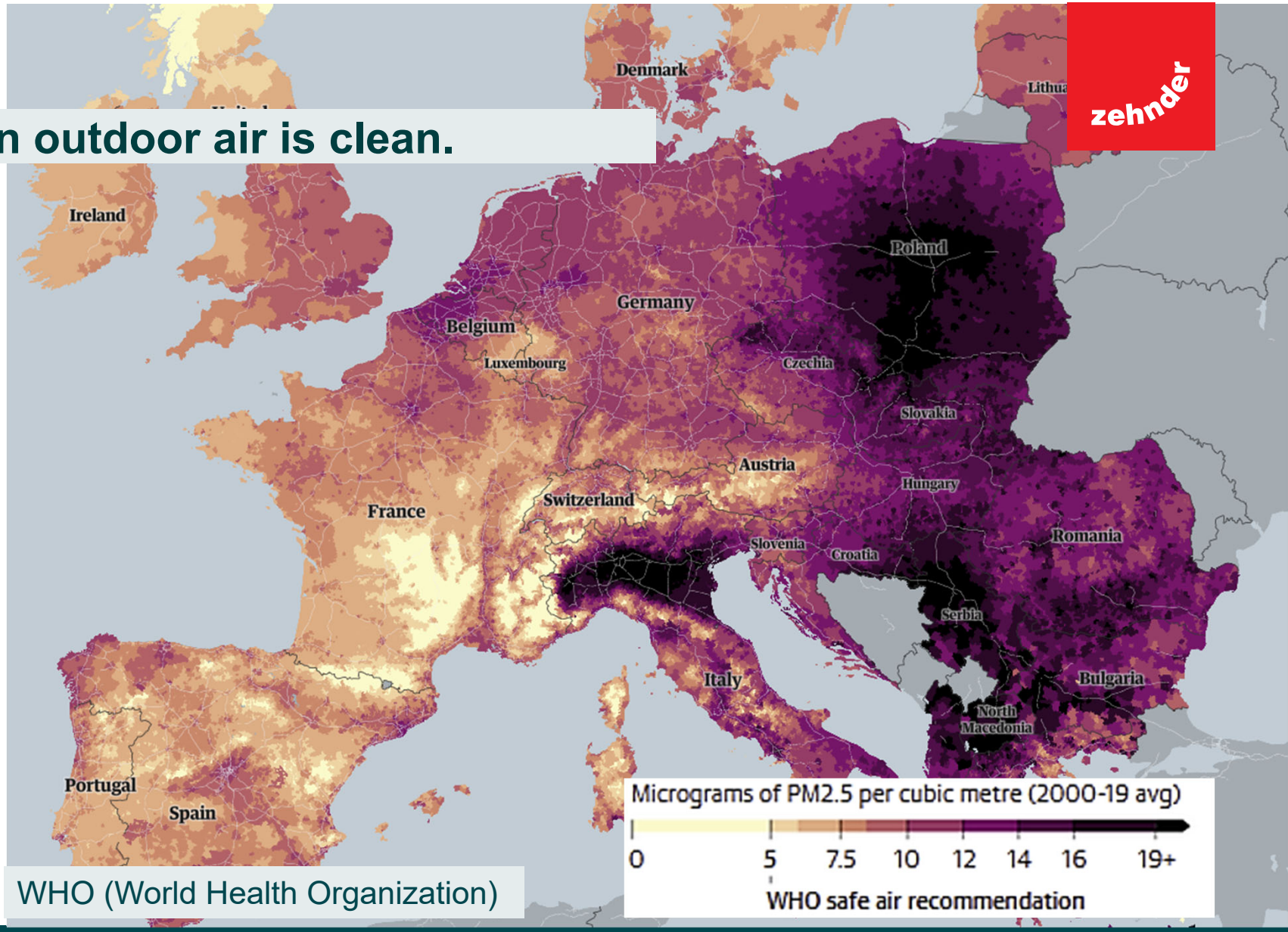
…in nature, CO_2 is decomposed via photosynthesis, whereas in houses the CO_2 must be extracted



Not all European outdoor air is clean.

Most European countries exceed WHO annual limits for $PM_{2.5}$ of 5 µg/m3.

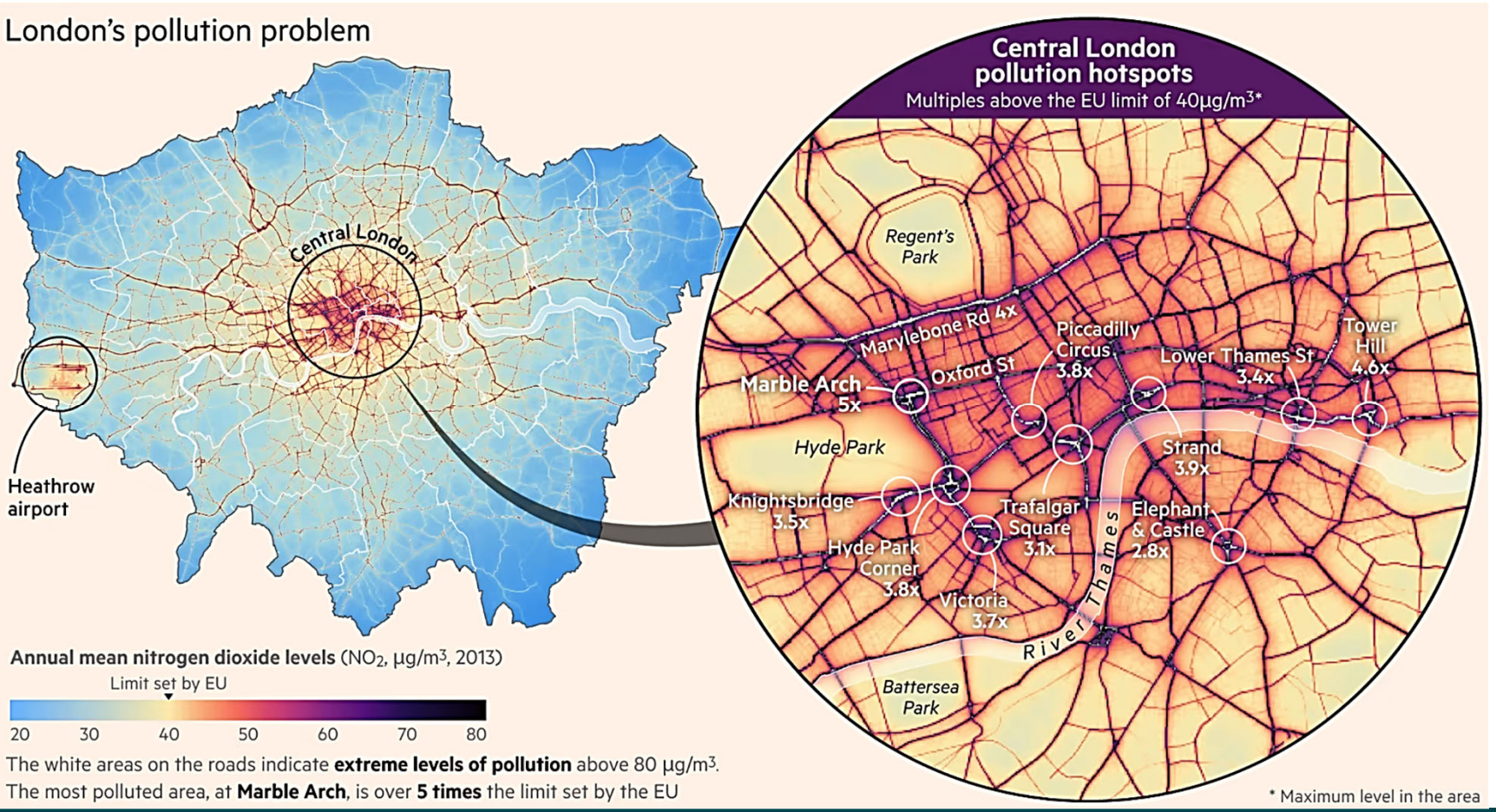
$PM_{2.5}$ (particulate matter) is extremely small and can penetrate deep into the lungs

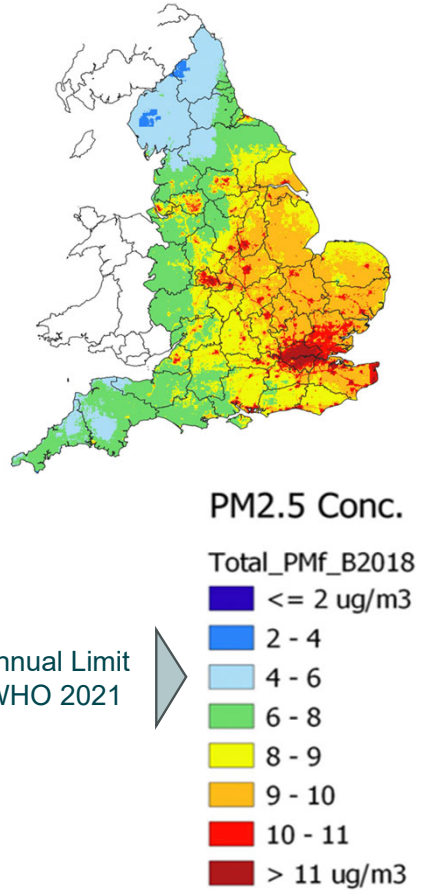


WHO (World Health Organization)

Air pollution in Europe varies locally: Example UK/London

In the UK, the WHO's annual limits for certain pollutants are exceeded in many regions.





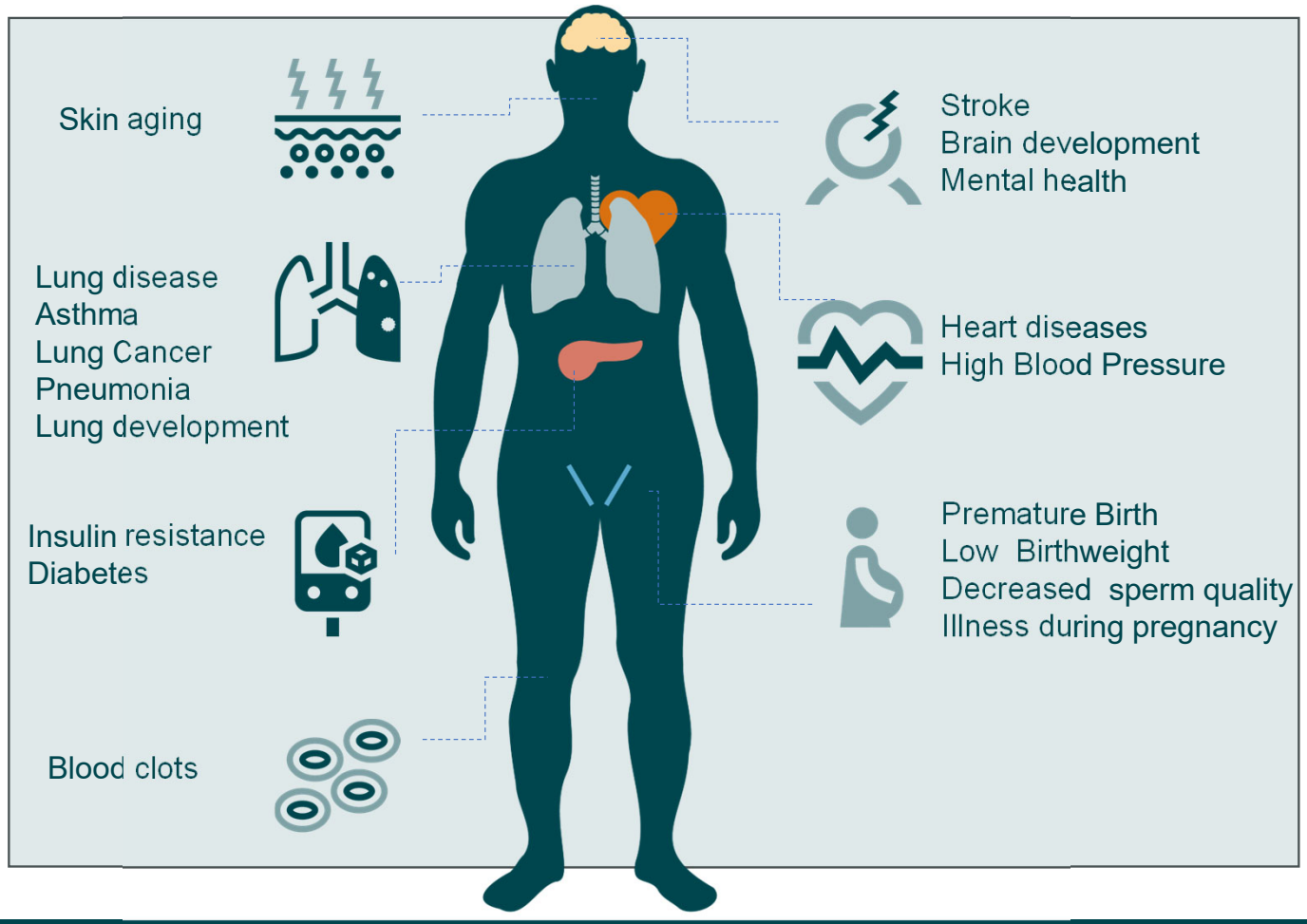
Over 4’000 Londoners hospitalised in three years due to harmful air pollution (2014 – 2016)

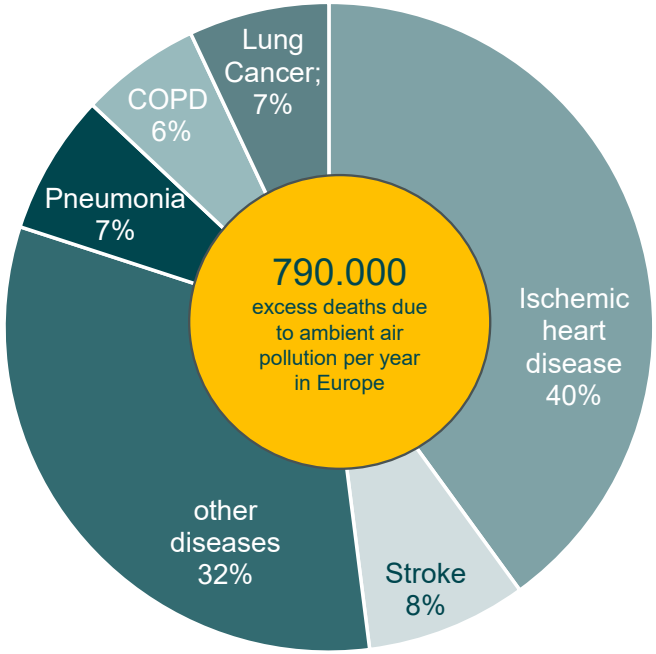
The area with the highest air pollution in the UK is London. London consistently experiences high levels of air pollutants, particularly nitrogen dioxide (NO_2) and fine particulate matter ($PM_{2.5}$)

A human hair is much larger than a respirable dust particle

Particles < 2.5 micrometers can get deep into the lungs, and may even get into the bloodstream

People need fresh air otherwise they risk health problems





The WHO has tightened air pollutant limits due to deaths.

WHO: Set limits for air pollutants values in µg/m³.				
Pollutant		Time	2045 levels	2021 levels
$PM_{2,5}$	PM < 2,5 microns	Annual 24-hour	10 25	5 15
PM_{10}	PM < 10 microns	Annual 24-hour	20 50	15 45
O_3	Ozone	Peak season 8-hour	- 100	60 100
NO_2	Nitrogen dioxide	Annual 24-hour	40 -	10 25
SO_2	Sulfur dioxide	24-hour	20	40
CO	Carbon monoxide	24-hour	-	4

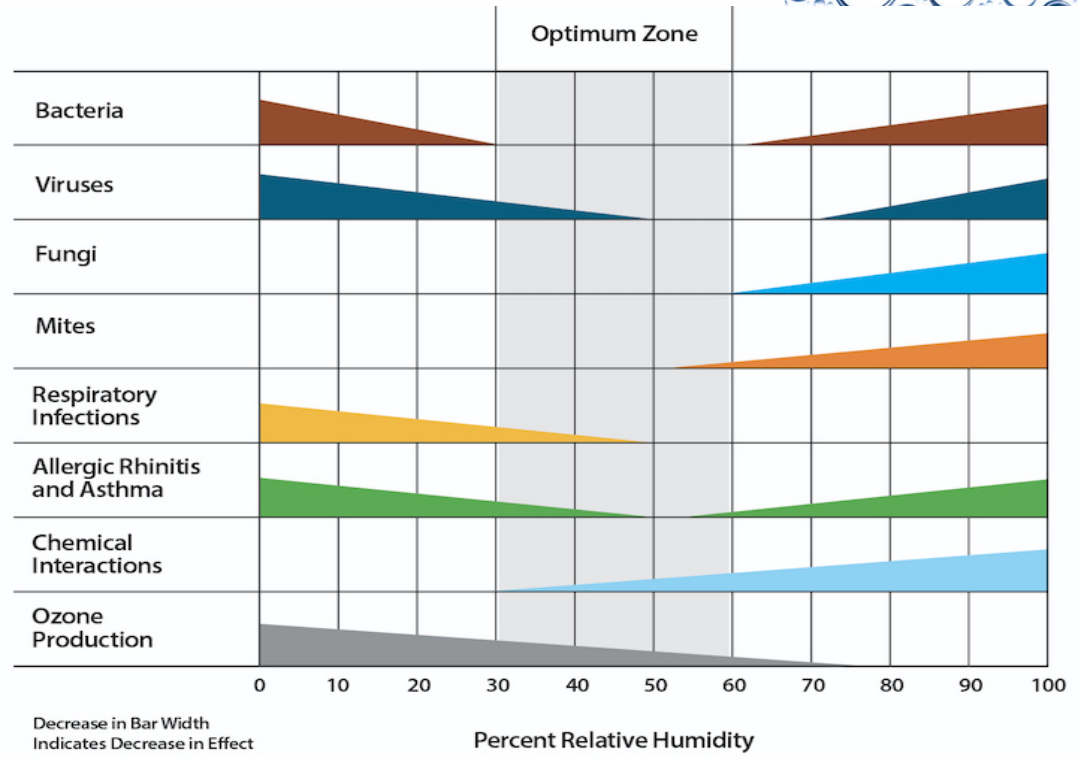
What is AQI – Air Quality Index?

The Air Quality Index (AQI) is a system that converts the perplexing measurements of pollutant concentrations into an easily comprehensible scale. This scale effectively communicates the health risks associated with ambient air pollution.

	US AQI Level		PM2.5 (µg/m³)	Health Recommendation (for 24-hour exposure)
	WHO PM2.5 (µg/m3) Recommended Guidelines as of 2024: 0-5,0			
	Good	0-50	0-9,0	Air quality is satisfactory with little or no risk.
	Moderate	51-100	9,1-35,4	Acceptable air quality: some pollutants may pose a minor risk for sensitive individuals, which should avoid outdoor activity.
	Unhealthy for sensitive groups	101-150	35,5-55,4	General public and sensitive individuals are in risk to experience health effects such as irritations and respiratory problems.
	Unhealthy	151-200	55,5-125,4	Health effects as aggravations to the heart and lung may be experienced by everyone; sensitive groups may experience more serious effects.
	Very Unhealthy	201-300	125,5-225,4	Health alert: everyone will be noticeable be affected. Sensitive groups should strictly avoid outdoor activity.
	Hazardous	301+	225,5+	Emergency conditions: the entire population is likely affected and should avoid outdoor activity.

Relative Humidity indoors should be between 30 - 60%

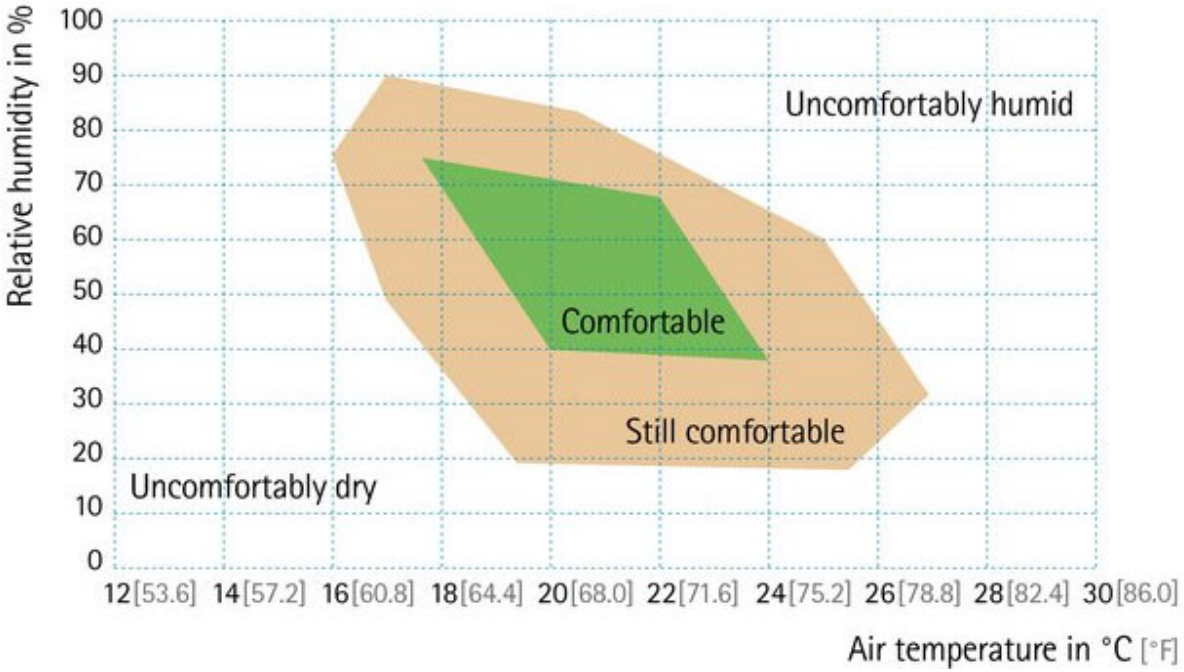
- When the relative humidity is low, there is a general feeling of 'dry air', which correlates with eye irritation and symptoms and increased respiratory problems, the typical **Sick Building Syndrome.**
- Higher humidity also creates a sense of "stuffy air" and increases the perception of odours and dustiness. In such environments, undesirable mould growth is encouraged, which can trigger human reactions or even damage indoor furniture and walls in the long term.
- It is therefore recommended that the relative humidity be kept within the **range of 30-60%.**



Comfortable indoor climate: warmer and more humid air is perceived as localised warm discomfort

- In central and northern Europe, people feel most comfortable at indoor temperatures between 20°C - 23°C and indoor relative humidities between 40% - 60% in winter.
- Warmer and more humid air is perceived as a localised warm discomfort in the respiratory tract, leading most people to conclude that the air is unacceptable. Tropical climates are hot and humid.

Comfort as a function of air humidity and air temperature

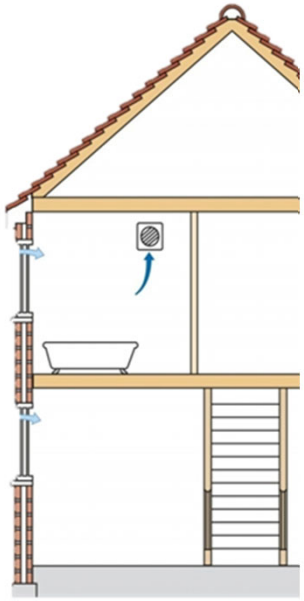


Key Considerations for a Ventilation Strategy

1. Types of ventilation systems (natural, mechanical, hybrid) and their applications
2. Assessing the building's characteristics and usage (size, layout, occupancy, etc.) – service and maintenance access
3. Regulatory requirements and standards (e.g., building codes, health & safety regulations)
4. Factors influencing ventilation choices: air tightness, occupancy, usage, energy efficiency, cost, and sustainability

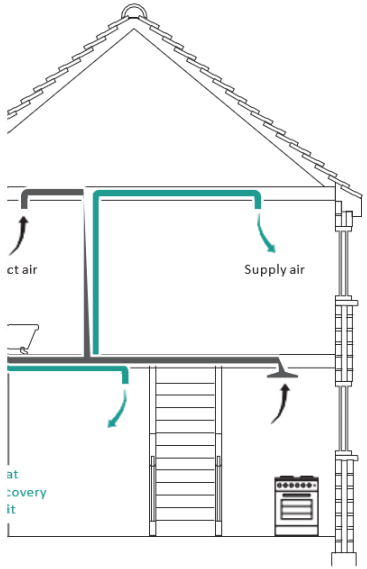
Ventilation Priorities: Key Areas and Activities

Ventilation concept variants



	Achieves a minimum air change rate of 0.37 ACH to deal with pollutants	Filters all air entering the building	Delivers fresh air to specific areas	Extracts stale/humid area from specific areas	Effective without occupant intervention?
Natural ventilation with intermittent extract fans	No	No	No	Partially	No
Mechanical extract ventilation	Yes	No	No	Yes	Yes
Balanced whole house ventilation with or without heat recovery	Yes	Yes	Yes	Yes	Yes

Table 1 – Characteristics of different ventilation strategies



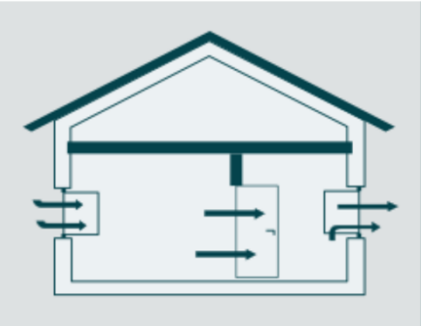
Regulations and ventilation concepts

Table 1.6 Types of ventilation system

System type	Dwellings covered by the guidance
Natural ventilation (paragraphs 1.47 to 1.59)	Less airtight dwellings
Continuous mechanical extract ventilation (paragraphs 1.60 to 1.66)	All dwellings
Mechanical ventilation with heat recovery (paragraphs 1.67 to 1.73)	All dwellings

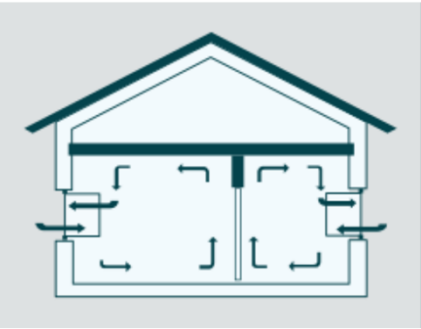
Ventilation type	Suitable for infiltration rate:
Natural ventilation (with intermittent mechanical extract)	≥ 5 $m^3/(h.m^2)$@50Pa
Continuous mechanical extract ventilation	≥ 3 $m^3/(h.m^2)$@50Pa
Continuous mechanical supply & extract ventilation	Any

Overheating



Cross ventilation: Open opposite windows and intermediate doors fully.

Ventilation time: 3 to 5 minutes, depending on the wind strength.



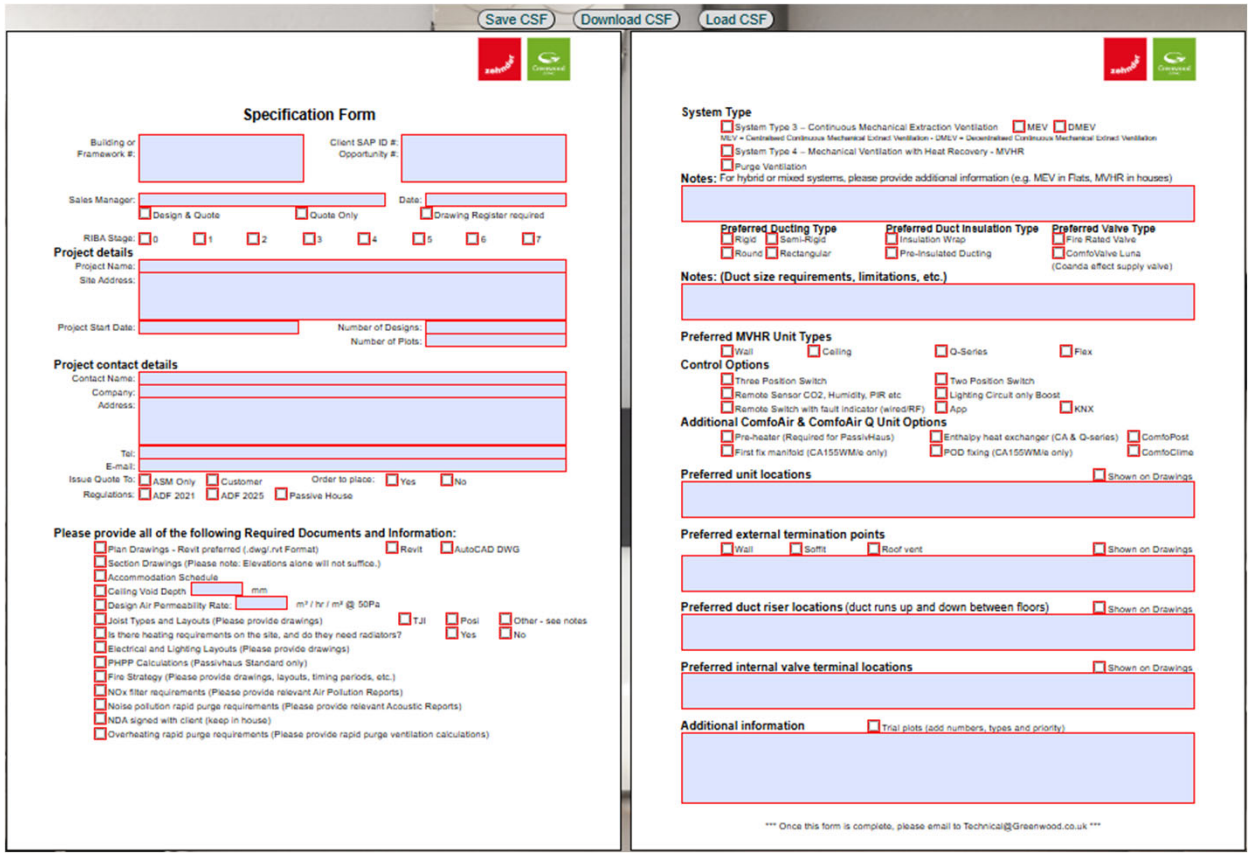
Shock ventilation: Open the window in the room fully.

Ventilation time: 5 to 10 minutes, depending on the wind strength.

1. Reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure
2. Minimise internal heat generation through energy efficient design
3. Manage the heat within the building through exposed internal thermal mass and high ceilings
4. Provide passive ventilation
5. Provide mechanical ventilation 6. provide active cooling systems.

Joined up thinking / Coordination

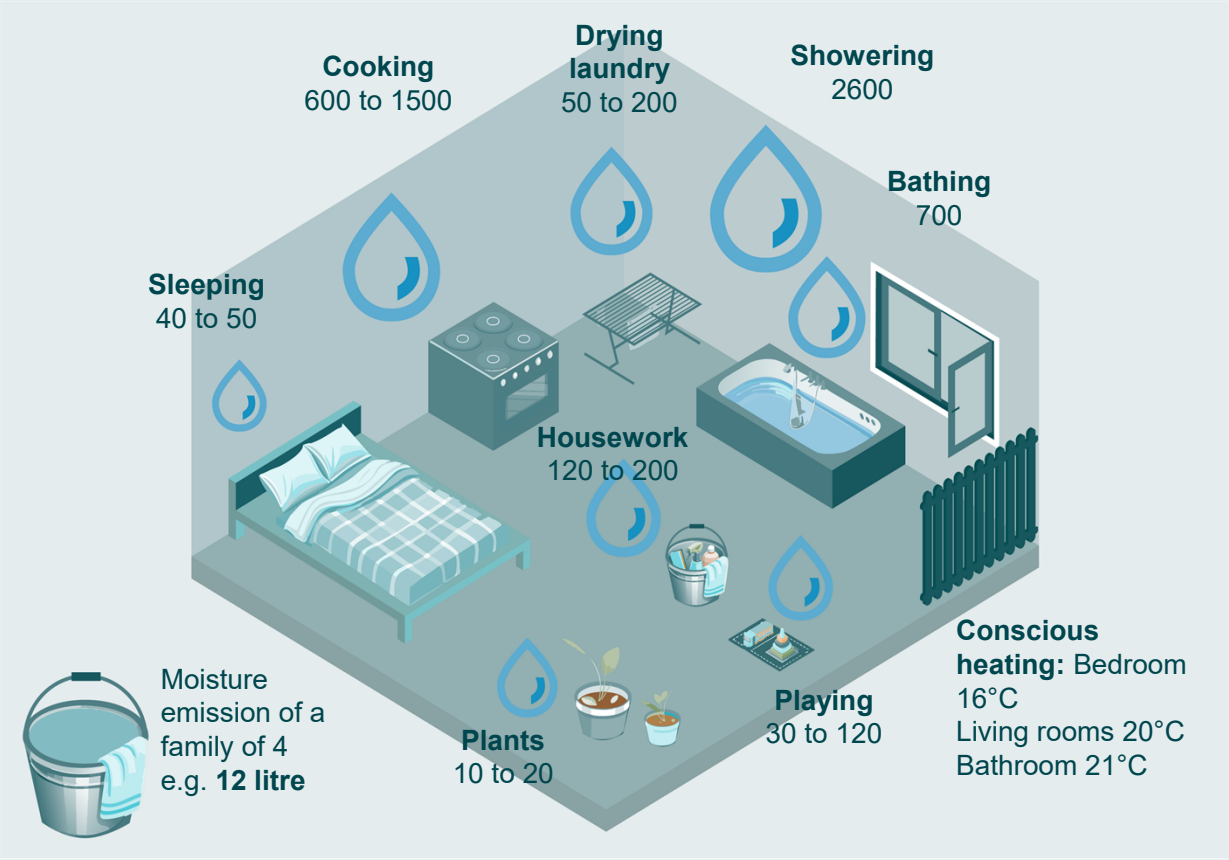
Client specification form
Ceiling void depth
Design air permeability
Joist Types and Layouts
PHPP Calculations
Fire strategy
NOx filter requirements
Noise pollution rapid purge requirement
Overheating rapid purge requirement
System type
Duct size
Wall or ceiling
Control options
Preferred unit location
Preferred external terminations
Preferred duct riser locations
Preferred internal valve terminal locations

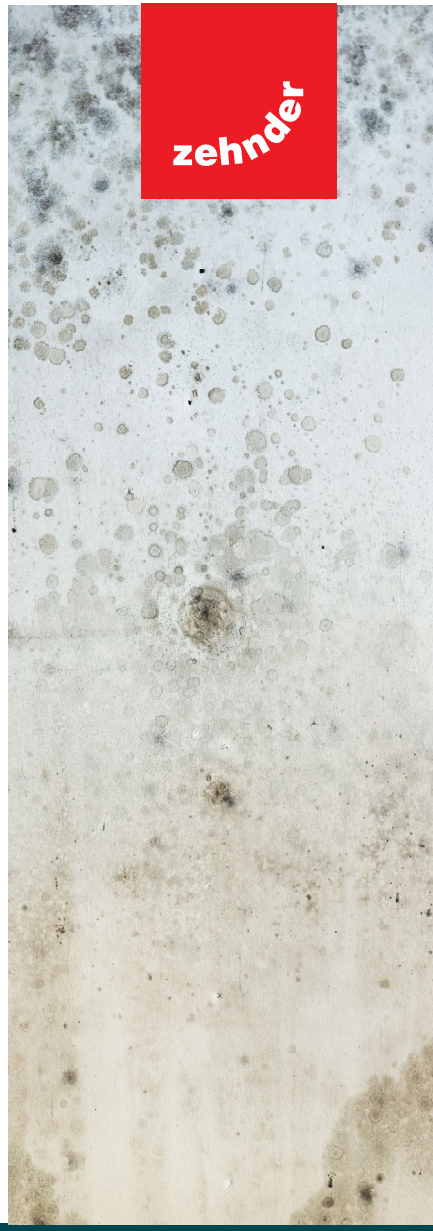


Risk Factors and How to Address Them

Sources of moisture/mould in houses

Sources of moisture in grams per hour





Rooms at risk of mould growth due to high humidity

Recommendation:

- Keep the humidity in these rooms below 60% (especially in winter).
- Use your HRV system to circulate fresh air and remove excess moisture.

Cellar

Bathroom

Kitchen

Case study

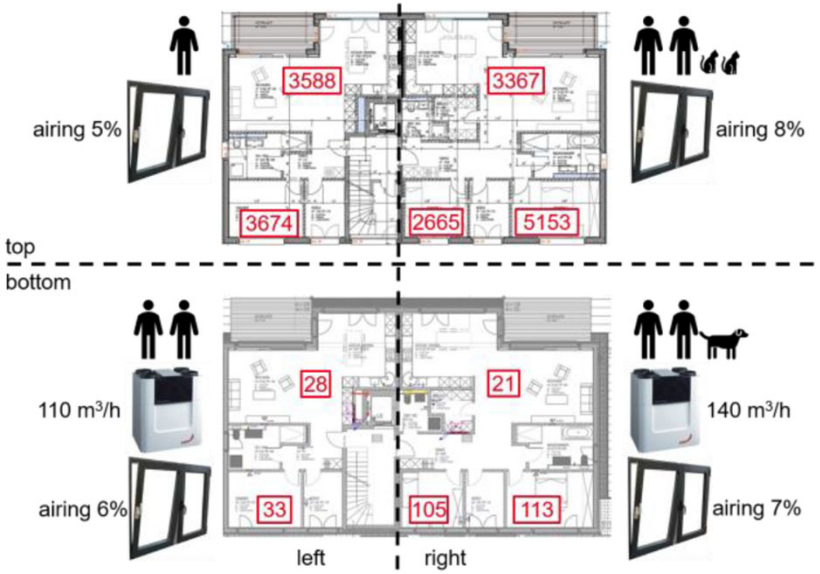


Figure 8. Infographic of plan view of the building with family size, airing factor, ventilation possibilities, and monitored number of hours with CO_2 above 1000 ppm.

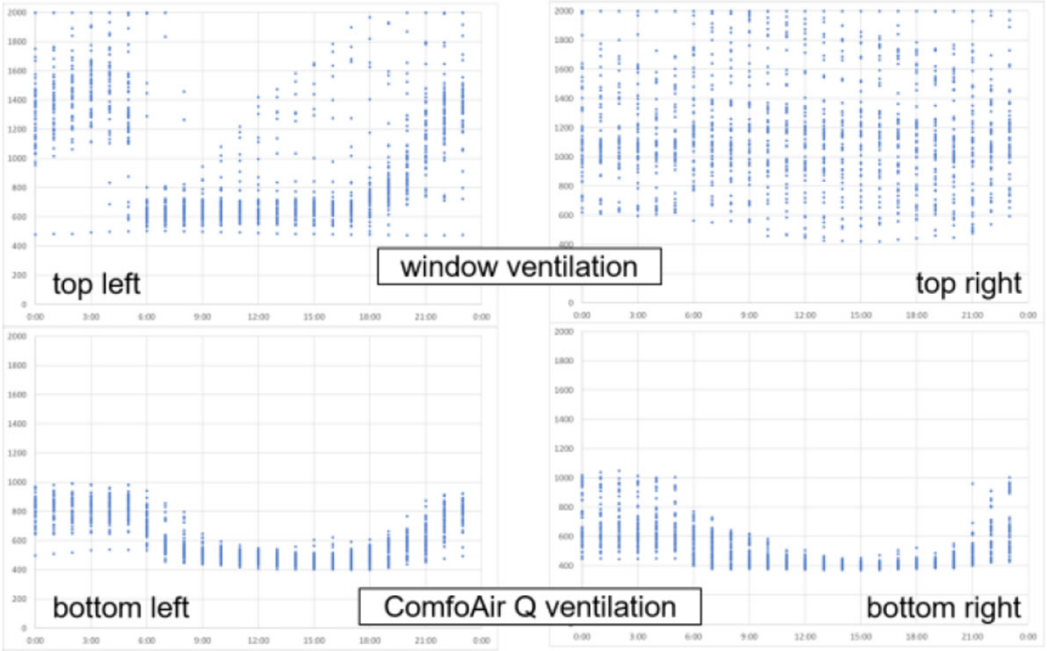


Figure 5. CO_2 values in master bedroom on all Tuesdays.

Cremers, B (2021) "The resulting CO2 levels and the heating/cooling consumption of apartments with balanced ventilation versus window ventilation"

Summary

Key Points Recap:

- Importance of proper ventilation for health and building integrity.
- Strategies to align with modern building standards.
- Prioritising areas to ventilate.
- Coordination and enforcement.
- Not all ventilation is equal in varying properties.

Next Steps:

- Attend Masterclass 2 to find out how to implement, see you 12th March


Questions