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Passivhaus and Bau Biology

Tomas Gaertner – Gale & Snowden Architects

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Bau Biology is about **our impact on the environment** and how the **environment** we create for ourselves **impacts on us**

SLEEP

36% of our lifetime we spend sleeping

For an average lifetime of 81 years
that’s 29 years entirely asleep

Healthy Design

How to create a healthy environment?

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Daylight ? BREEAM uses daylight factor calculations to assess health benefits

Low VOC ?

BREEAM	<300	µg /m3	
Well Building	<500	µg /m3	
Germany (EA)	200-300	µg /m3	‘normal’

“air with no known contaminants at harmful concentrations” (CIBSE)

… but what is a non-harmful concentration for a carcinogenic, mutagenic or reprotoxic agent?

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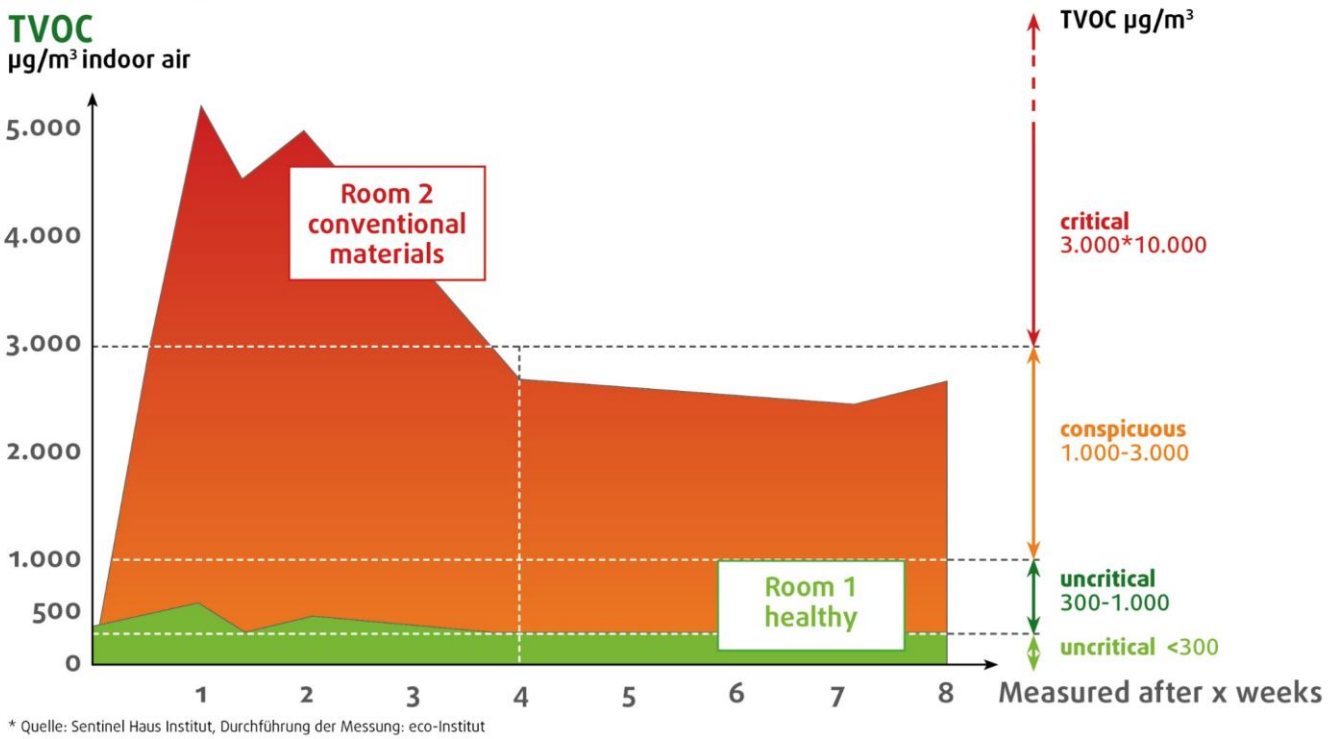
Consequences of inddor air pollutants in products:

TVOC in children´s rooms

Results of a study with eco-institut



* Quelle: Sentinel Haus Institut, Durchführung der Messung: eco-Institut

SENTINEL HAUS INSTITUT in Kooperation mit TÜVRheinland® Genau. Richtig.

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In addition carcinogenic heavy metals from building components accumulate in airborne dust

Antimony	Flame retardants
Arsenic	Timber treatment, PVC
Lead	Paints and lacquers, plastic stabilisers
Cadmium	PVC, pigments
Chrome	Timber treatment, paints and lacquers, plastics, textile treatments
Copper	Carpets, pigments, timber treatment, pipework
Nickel	PVC, pigments
Mercury	Timber treatment, paints and lacquers, leather, plastics, textile treatments
Tin	Timber treatment, flame retardants, preservatives, PVC, paints and lacquers, plastics

One in two people will encounter a cancer diagnosis in their lifetime …

…a disease commonly believed to be preventable.

It is more common for an individual to be diagnosed with cancer than to get married or have a child.

(Macmillan Cancer Support UK)

Healthy Design – SBM2015

Clearly defined, scientific, measurable targets for air quality, indoor climate, lighting and day light, radiation

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BAUBIOLOGIE MAES / Institut für Baubiologie + Ökologie IBN

GUIDELINES

Supplement to the Standard of Building Biology Testing Methods SBM-2008

BUILDING BIOLOGY EVALUATION GUIDELINES

FOR SLEEPING AREAS

The Building Biology Evaluation Guidelines are based on the precautionary principle. They are specifically designed for sleeping areas associated with long-term risks and a most sensitive window of opportunity for regeneration. They are based on the building biology experience and knowledge and focus on achievability. In addition, scientific studies and other recommendations are also consulted. With its professional approach, building biology testing methods help identify, minimize and avoid environmental risk factors within an individual's framework of possibility. It is the Standard's goal to identify, locate and assess potential sources of risk by considering all subcategories in a holistic manner and implementing the best possible diagnostic tools available with analytic expertise in order to create indoor living environments that are as exposure-free and natural as practicable.

No Concern This category provides the highest degree of precaution. It reflects the unexposed natural conditions or the common and nearly inevitable background level of our modern living environment.

Slight Concern As a precaution and especially with regard to sensitive and ill people, remediation should be carried out whenever it is possible.

Severe Concern Values in this category are not acceptable from a building biology point of view, they call for action. Remediation should be carried out soon. In addition to numerous case histories, scientific studies indicate biological effects and health problems within this reference range.

Extreme Concern These values call for immediate and rigorous action. In this category international guidelines and recommendations for public and occupational exposures may be reached or even exceeded.

If several sources of risk are identified within a single subcategrory or for different subcategories, one should be more critical in the final assessment.

Guiding Principle:

Any risk reduction is worth achieving. Reference values are meant as a guide. Nature is the ultimate standard.

The small print at the end of each subcategory of the Building Biology Standard is meant as a comparative guide, e.g. legally binding exposure limits or other guidelines, recommendations and research results or natural background levels.

Building Biology Evaluation Guidelines for Sleeping Areas SBM-2008, Page 1	**No** Concern	**Slight** Concern	**Severe** Concern	**Extreme** Concern

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Healthy Design – SBM2015

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B INDOOR TOXINS, POLLUTANTS, INDOOR CLIMATE

1 FORMALDEHYDE and other Toxic Gases

Formaldehyde in microgram per cubic meter		**µg/m³**	**< 20**	**20 - 50**	**50 - 100**	**> 100**

MAK: 370 µg/m³, BGA: 120 µg/m³; WHO: 100 µg/m³; AGÖF reference value 'normal': 30 µg/m³; VDI: 25 µg/m³; irritation of mucous membranes and eyes: 50 µg/m³; odor detection threshold: 60 µg/m³; immediate danger to life: 30.000 µg/m³; nature < 2 µg/m³; 100 µg/m³ = 0.083 ppm

3 PESTICIDES and other Semi-Volatile Organic Compounds (SVOV)

Pesticides		air	**ng/m³**	**< 5**	**5 - 25**	**25 - 100**	**> 100**
e.g. PCP, lindane, permethrin, chlorpyrifos, DDT, dichlofluanid...		wood, material	**mg/kg**	**< 1**	**1 - 10**	**10 - 100**	**> 100**
		dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 10**	**> 10**
		material with skin contact	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 10**	**> 10**
PCB		dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 5**	**> 5**
Fire Retardants	chlorinated	dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 10**	**> 10**
	halogen-free	dust	**mg/kg**	**< 5**	**5 - 50**	**50 - 200**	**> 200**
PAH		dust	**mg/kg**	**< 0.5**	**0.5 - 2**	**2 - 20**	**> 20**
Plasticizers		dust	**mg/kg**	**< 100**	**100 - 250**	**250 - 1000**	**> 1000**

Sum total values in nanogram per cubic meter (air) and in milligram per kilogram (material, wood, dust), respectively.

Values for dust apply to typical mixtures of substances. Values for adsorbed plasticizers in dust (sum total: x 2); PCB according to LAGA. PAH according to EPA.

5 PARTICLES and FIBERS (Fine Particulate Matter, Nanoparticles, Asbestos, Mineral Fibers...)

Indoor concentrations of particulate matter, fibers or dust should be below the common, uncontaminated outdoor concentrations. Asbestos should not at all be detectable in indoor air, house dust and on indoor surfaces.

Former building biology reference values for asbestos fibers, SBM-2000: < 100 no, 100-200 slight, 200-500 strong, > 500/m³ extreme anomaly

Asbestos fibers in air - BGA: 500-1000/m³; TRGS target: 500/m³; EU: 400/m³; WHO: 200/m³; outdoor air: 50-150/m³; clean air region: 20/m³; Particulate matter in air (annual avg.) - BImSchV: 40 µg/m³; EU: 50 µg/m³ (< 10 µm); EPA: 25 µg/m³ (< 2.5 µm); VDI: 75 µg/m³; TA: 150 µg/m³; Alps 3000 m: 5-10 µg/m³; rural: 20-30 µg/m³; urban: 30-100 µg/m³; indoor with tobacco smoke: 10 000 µg/m³; smog warning: 800 µg/m³

6 INDOOR CLIMATE (Temperature, Humidity, Carbon Dioxide, Air Ions, Air Changes, Odors...)

Relative humidity in percent	**% r.h.**	**40 - 60**	**< 40 / > 60**	**< 30 / > 70**	**< 20 / > 80**
Carbon dioxide in parts per million	**ppm**	**< 600**	**600 - 1000**	**1000 - 1500**	**> 1500**

MAK: 5000 ppm; DIN: 1500 ppm; VDI: 1000 ppm; USA (occupational/classrooms): 1000 ppm; unventilated bedroom after one night or classroom after a one-hour lesson: 2000-4000 ppm; nature in 2008: 380 ppm, in 1985: 330 ppm; annual increase: 1-2 ppm

Small air ions per cubic centimeter air	**/cm³**	**> 500**	**200 - 500**	**100 - 200**	**< 100**

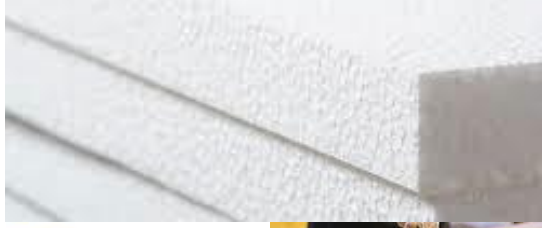
Nature by the sea: > 2000/cm³; clean outdoor air: 1000/cm³; rural: < 800/cm³; urban: < 700/cm³; industrial areas/traffic: < 500 /cm³; indoor with static electricity: < 300/cm³; indoor with tobacco smoke: < 200/cm³; smog < 50/cm³; continuous decrease of air ions over past years/decades

Air electricity in volt per meter	**V/m**	**< 100**	**100 - 500**	**500 - 2000**	**> 2000**

DIN/VDE: occupational 40 000 V/m, general 10 000 V/m; nature: ca. 50-200 V/m, foehn: ca. 1000-2000 V/m, thunderstorm: 5000-10 000 V/m





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Performance Monitoring

CO2 as air Quality indicator

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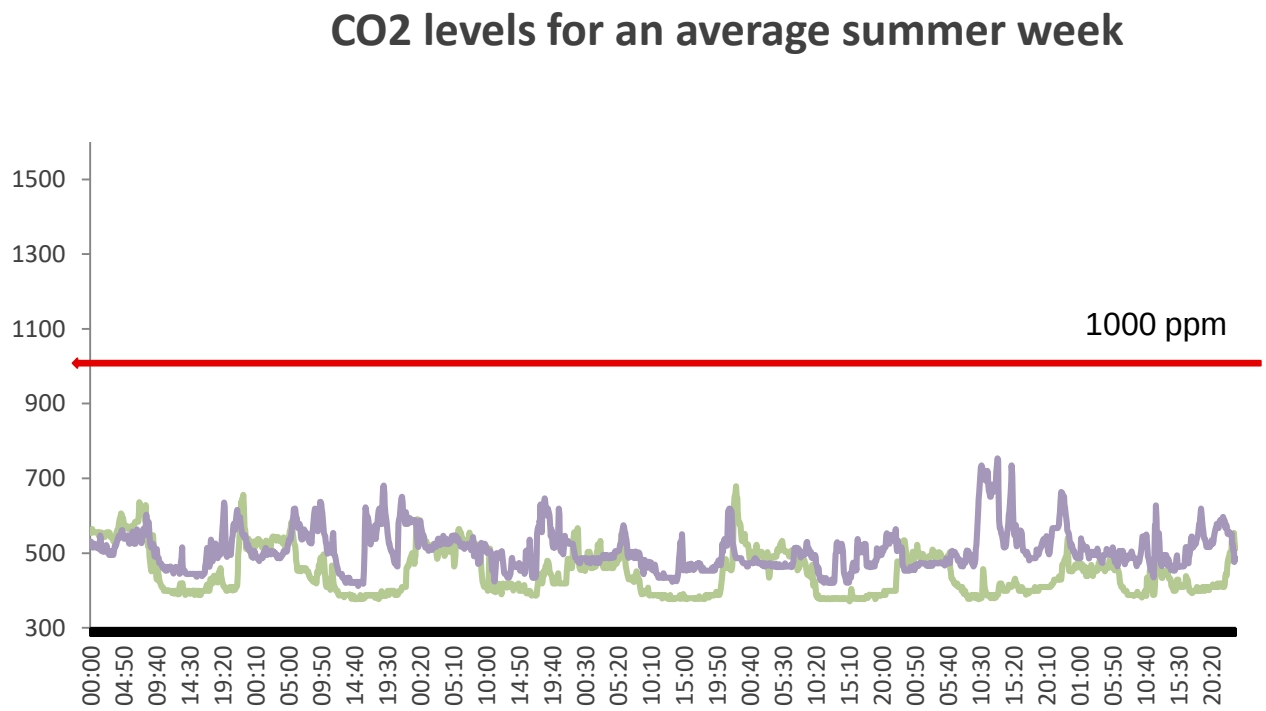

CO2 monitoring data from 2 year BPE study on a multiresidential Passivhaus

Tenants successfully managed optimum internal air quality during summer

CO2 remains within an optimum range of <1000 ppm

Performance Monitoring

CO2 as air Quality indicator

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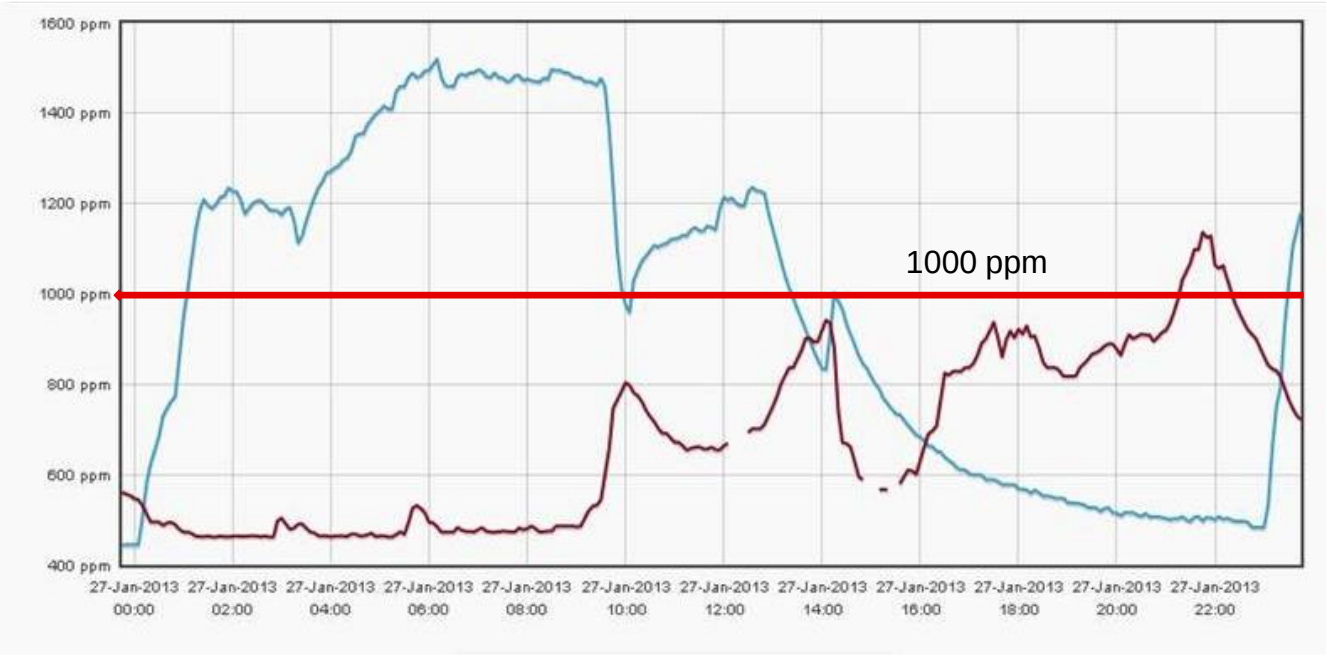
CO2 levels for a winter day



MVHR was set to deliver 0.35 air changes in winter

CO2 levels in bedrooms with door closed regularly exceeded 1500ppm

Healthy Building
Air Quality

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**Ventilation is key - ** What we now do differently:

- CO2 and humidity controlled MVHR
- Use of enthalpy heat exchanger once building has dried out properly
- Good quality, tight fitting filters and regular filter checks
- Increase MVHR ventilation rates to 0.5-0.6 ach rather than 0.3 ach

… but what about dry air in winter?

Healthy Building

Air Quality – The role of materials

Since the 1960s a shift changed happened in construction and a vast range of highly processed, petro-chemical based, complex construction materials was developed

sd value ~2

(acts as Vapour check)

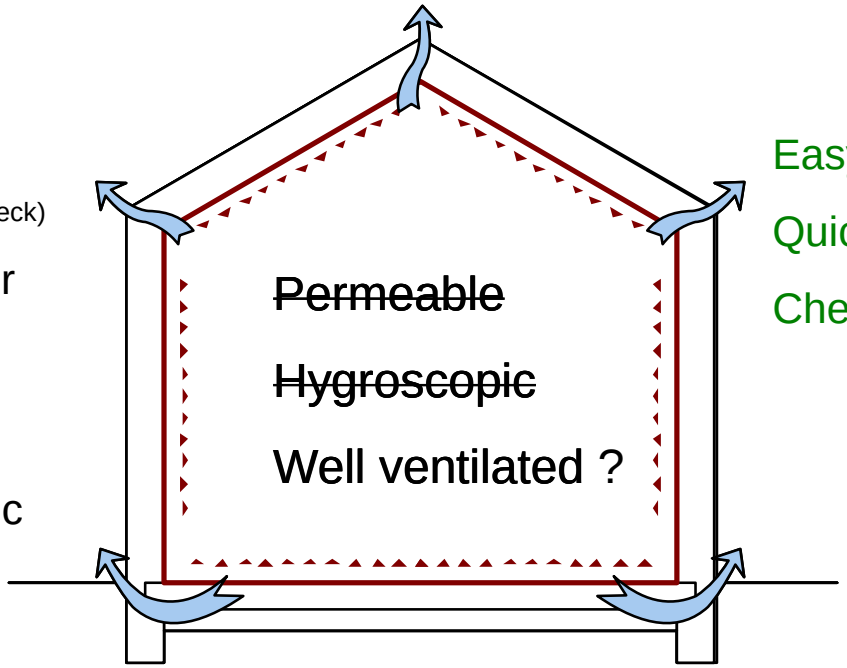
no RH buffer

VOC

Toxic

Carcinogenic

Mutagenic

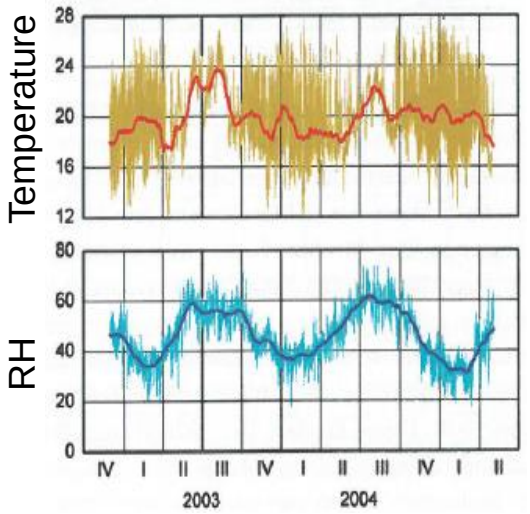


Easy to work

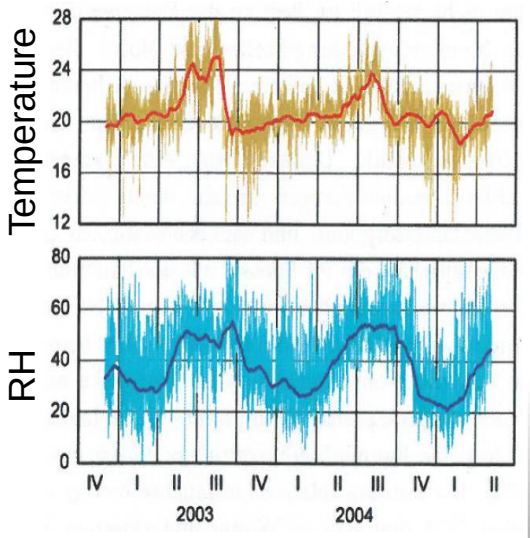
Quick

Cheap (?)

Period, uninsulated, solid brick dwelling with masonry stove
(Temperature and RH)

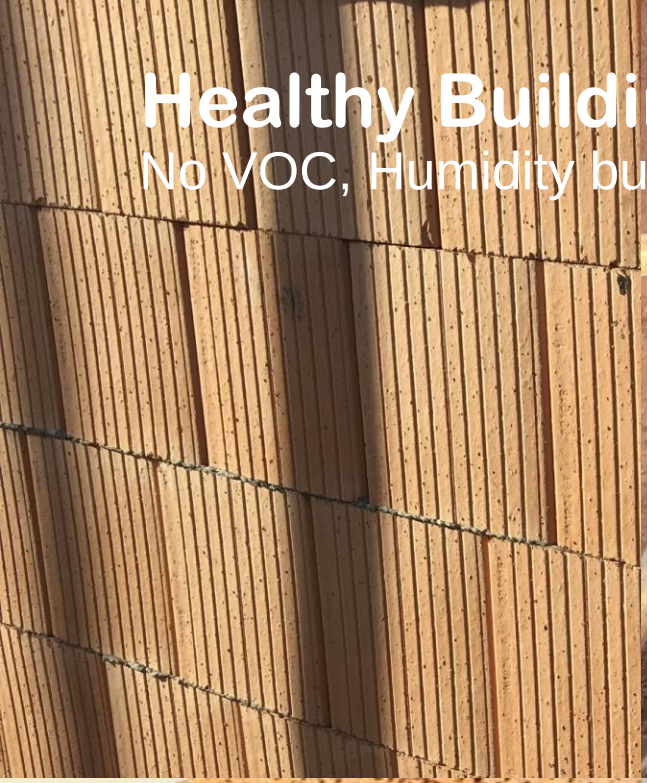


1980, insulated, concrete frame dwelling with central heating
(Temperature and RH)



Healthy Building

No VOC, Humidity buffering materials



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Opportunity for healthy building

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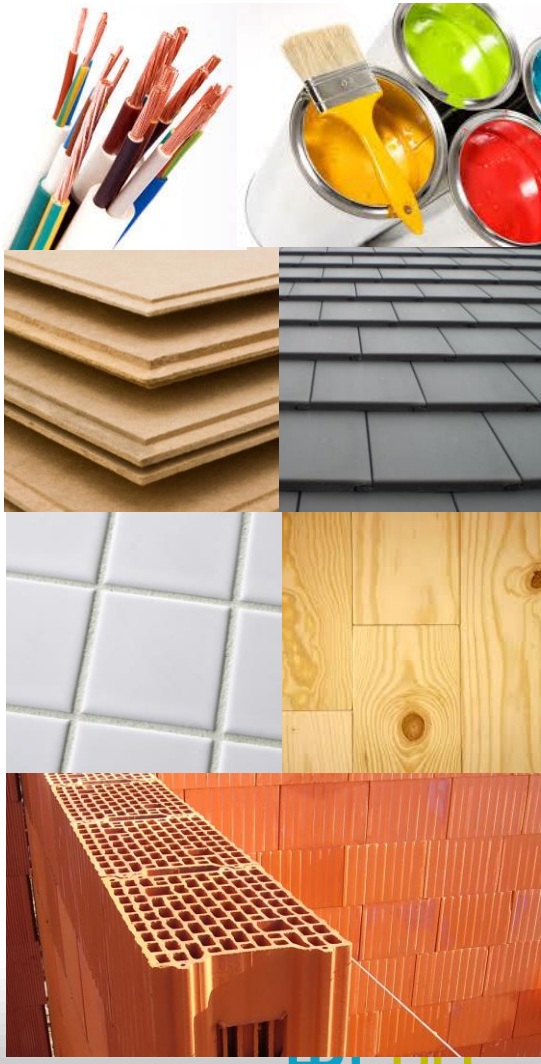
Key strategies for material selection included

- Focus on products with full content declarations
- Low VOC mineral paints and pure solid hard oils
- Use ‘EMICODE EC 1’ plus as starting point
- Hygienic easy to clean surfaces
- Dry or quick drying construction
- Hygroscopic and highly permeable surfaces
- No plastic finishes and fabrics that lead to electro statics
- Local, natural, unprocessed materials where practical
- PVC and phthalate free
- Pleasant or neutral odour
- Minimal environmental impact over its entire life
- Low radioactivity
- Well considered ventilation strategy, CO2 and humidity controlled!



SLEEP

Thank You!