

The Effect of New Building Concepts on Indoor Radon

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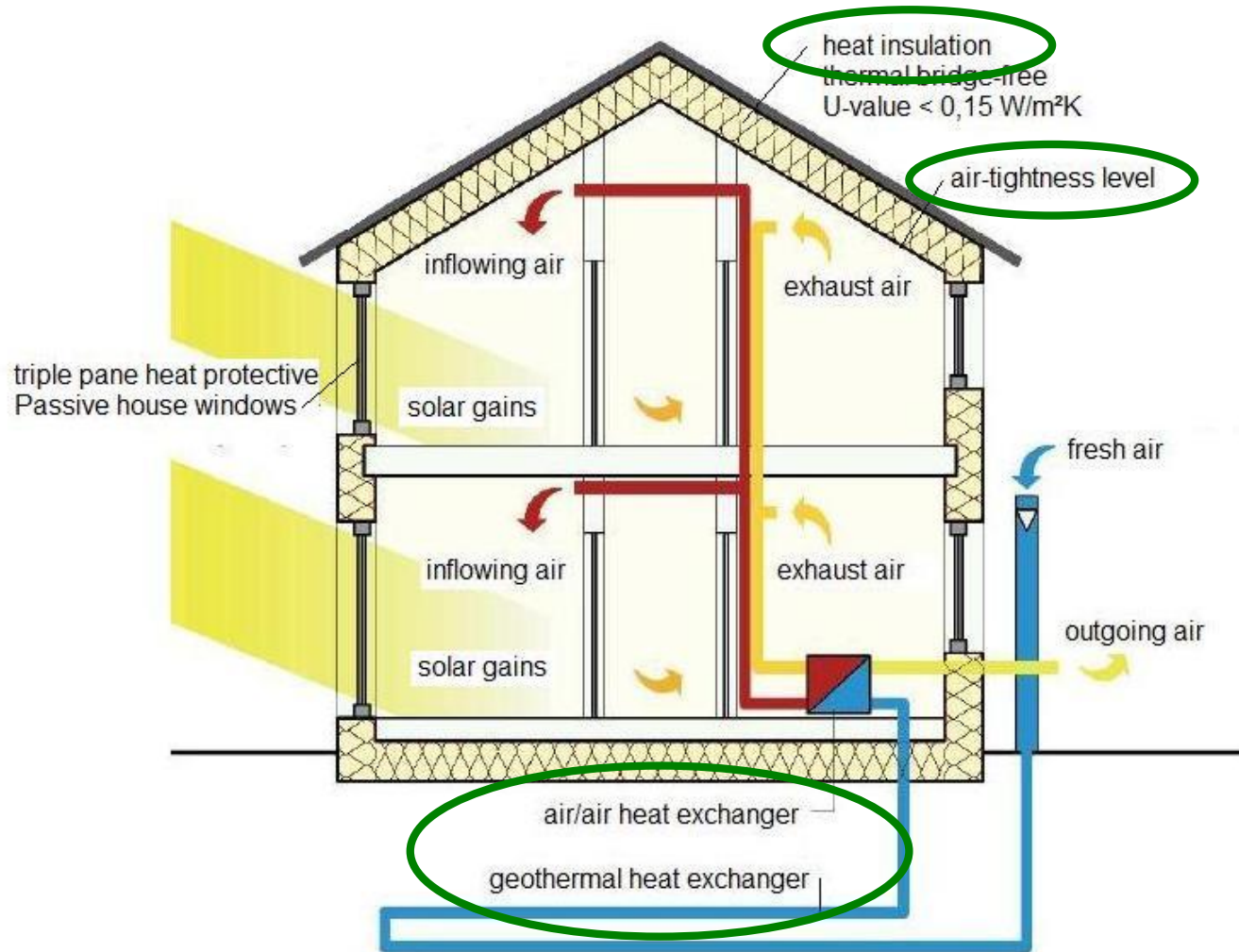
New Building Concepts

Building sector is at present responsible for more than 40% of EU energy consumption.

New building concepts all aim at a new approach for the design, construction and operation → reach a high level of energy efficiency and sustainability.

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|--|--|
| - Bioclimatic House | - Passive house |
| - BREEAM Building | - Plus Energy House |
| - Carbon Free House | - TBQ: Total Quality Planning and rating |
| - Climate: Active House | - Triple Zero House |
| - CSH: Code for Sustainable Homes | - Ultra Low energy House |
| - Eco-Building | - Very Low Energy House |
| - Emission Free House | - Zero Carbon house |
| - Energy Saving House | - Zero Emission House |
| - Energy Self-Sufficient House / Energy Autark House | - Zero Energy House |
| - Green building | - Zero Heating Energy House |
| - Lider A | - 3 - Liter House |
| - Low Energy House | |

Main Features of Energy Efficient Building Construction



Radon and Energy Efficient Buildings



What is the effect of such new building concepts on indoor radon levels?

Extensive study within the EU-project RADPAR (2009 – 2012; new constructions, not retrofitting !!!):

- Identification of construction, heating and ventilation technologies of European energy efficient buildings
- Assessment of the potential effect on indoor radon
- Radon measurements in 28 passive houses (screening) and 9 low energy and passive houses (detailed radon diagnosis)
- Recommendations to prevent adverse effects of new technologies on indoor radon

Radon Measurements - Screening



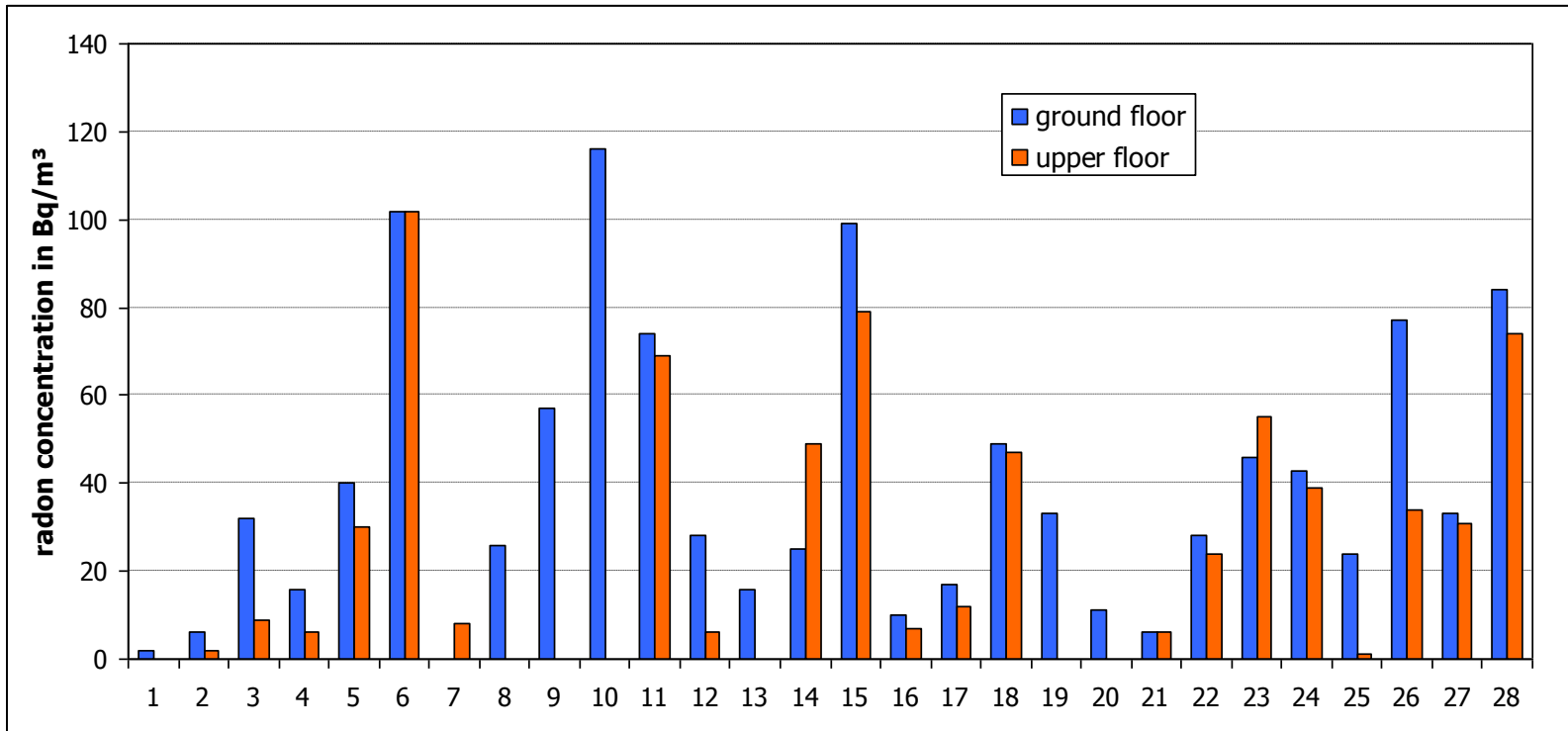
28 passive houses in radon prone areas
(radon potential class 3!)

[Passive house definition (Passive House Institute Darmstadt): airtightness $n_{50} < 0.6$ 1/h, specific annual heating demand ≤ 15 kWh/m², specific annual primary energy consumption ≤ 120 kWh/m²]

Long-term passive radon measurements (at least 2 months)
in the two most occupied rooms

Specific questionnaire

Radon Measurements - Screening

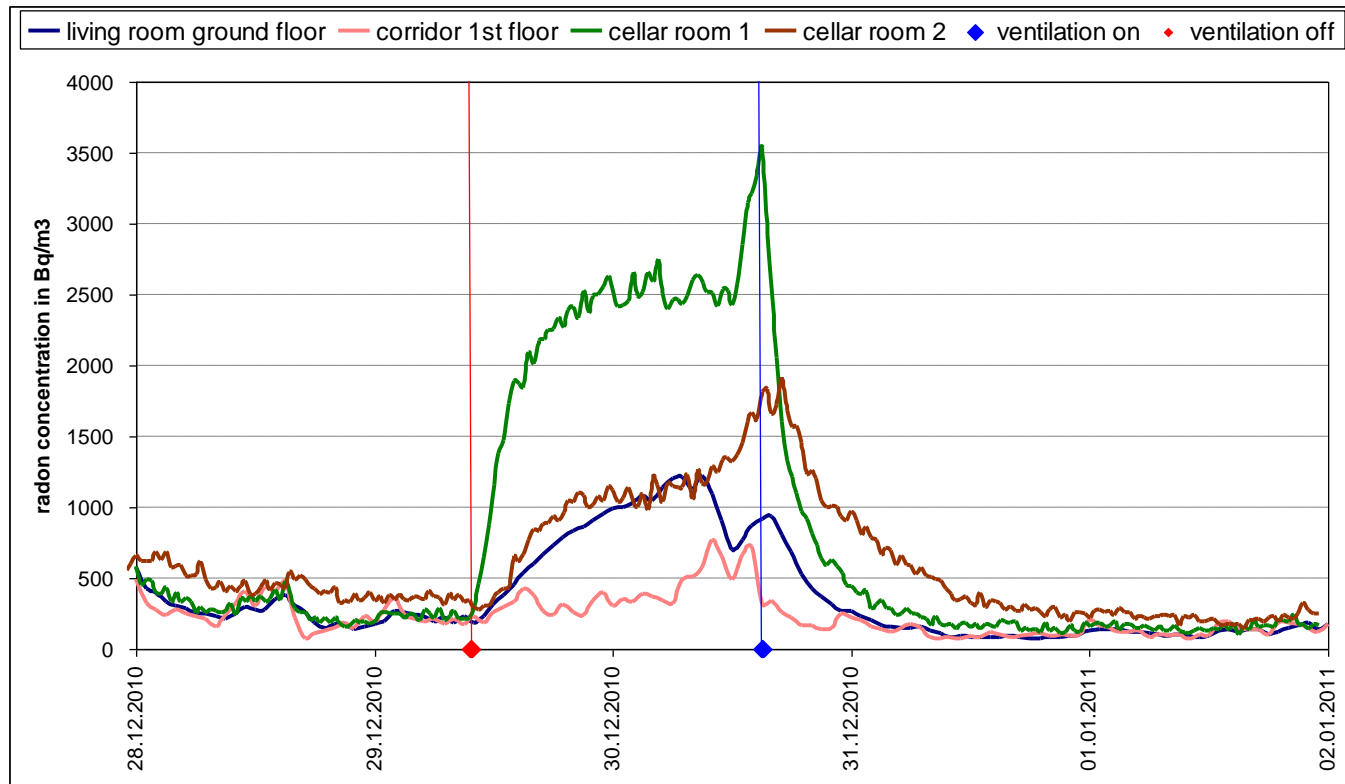


Mean value of all house mean values: $34 \pm 28 \text{ Bq/m}^3$
Mean value of ground floors: $39 \pm 32 \text{ Bq/m}^3$
Mean value of upper floors: $31 \pm 30 \text{ Bq/m}^3$
Highest value measured: $116 \pm 16 \text{ Bq/m}^3$
Mean n50-value: 0.33 1/h

Detailed Radon Measurements – Main Results

Ventilation ON/OFF

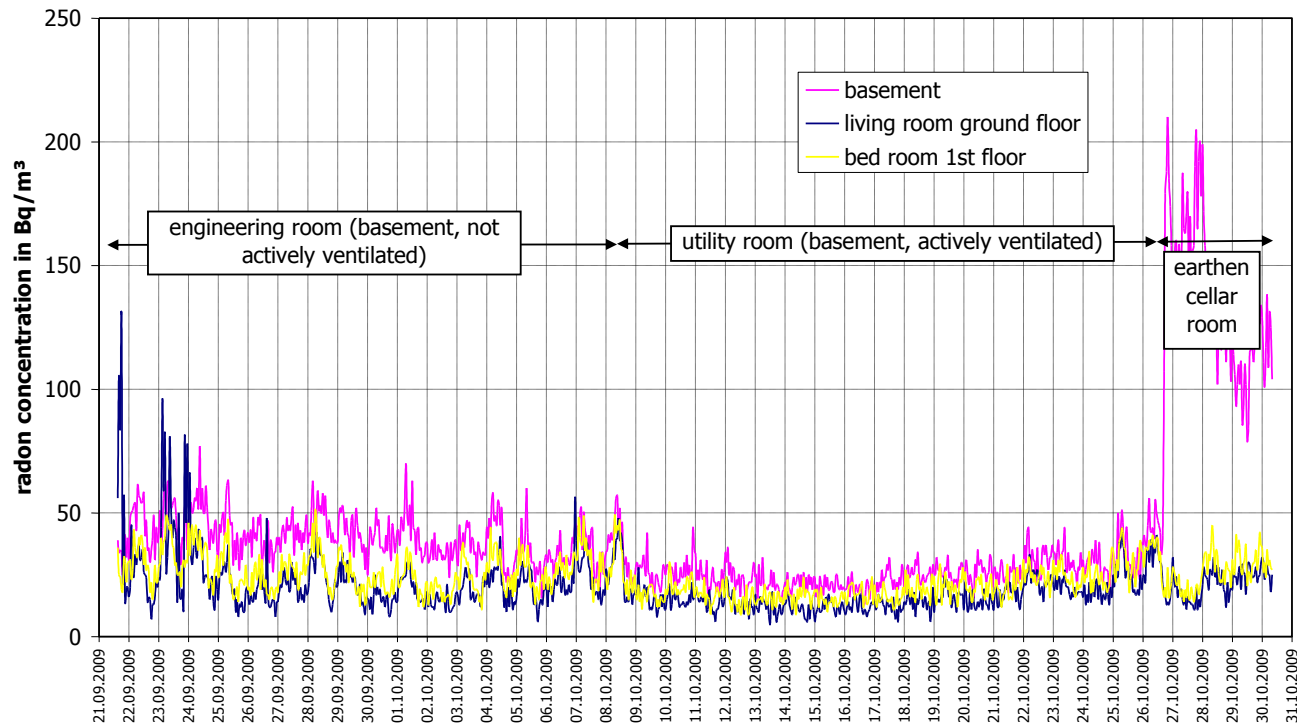
6- to 10-fold increase in radon level; depends on geogenic radon potential, leakages in foundations, location of room



Detailed Radon Measurements – Main Results

Room not included in the mechanical ventilation system and inside thermal envelope: No to little increase of radon level

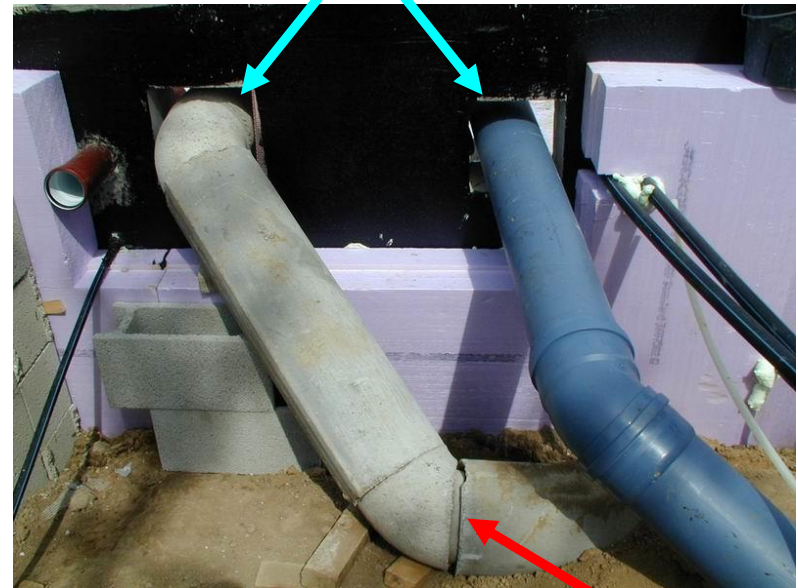
Room not included in the mechanical ventilation system and outside thermal envelope: Moderate to substantial increase of radon level



Detailed Radon Measurements – Main Results

Ground-coupled heat exchanger with concrete / plastic earth tubes

Tests in low energy house with both tube systems.



$C_{rn,concrete} \sim 1.5 C_{rn,plastic}$

Recommendations

Construction Technologies (3):

- building materials
- construction elements
- airtightness
- penetrations

Heating Systems (1):

- combustion air
- kind of fuel

Ventilation (8):

- ground-coupled heat exchanger with earth tubes
- construction of the air intake
- pressure disbalance
- switching off the ventilation system
- non-ventilated rooms

Recommendations - Examples

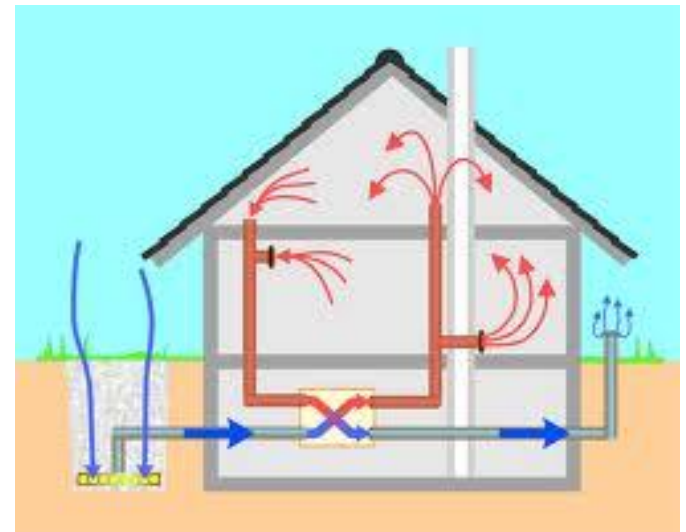
AIRTIGHTNESS

With respect to radon the airtightness of the foundation is the key factor. It is recommended to include the basement in the thermal envelope. If this is not wanted, then the foundation has to be constructed according to the general radon guidelines for new buildings which are available in most EU countries. A radon measurement for verification is recommended.

AIR WELLS

It is recommended not to use air wells at all.

Solutions – using a membrane and a siphon – exist which should prevent radon from the surrounding soil to enter the air well. However, the membrane may get leaky or the siphon may dry out. Furthermore, radon exhaled from the filling material is still drawn into the building.



Conclusions



Combination of (extremely) airtight building shell (foundation !) and controlled mechanical ventilation in new constructions results in (very) low radon levels.

Certain features of the new technologies may cause high radon levels (untight earth tubes of ground-coupled heat exchangers, air wells, etc.).

A number of recommendations were compiled which are meant to help building professionals and occupants to plan and build energy efficient homes with very low indoor radon levels.

Radon measurements may also serve as a tool of quality control for the building and ventilation system (e.g. untight earth tubes, airtightness of foundations (microfissures, penetrations), pressure disbalances).

Next step is to inform the relevant consultants, manufacturers, and building professionals as well as the public. Appropriate information material (brochures, WWW, etc.) has to be compiled and published.



**Thank you for
your attention!**

