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Environmental performance of energy efficient residential building – a case study of Lithuania

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Problem

- **Directive 2012/31/EU** obliges MS to start building NZEB from 2020;
- **Directive on energy efficiency 2012/27/EU** aims to increase energy efficiency in buildings;
- In frames of both directives, **energy efficiency is understood as decrease of operational energy consumption of the building. This is correct just for inefficient or standard buildings;**
- **Meanwhile...** energy efficient building, as a rule, **requires more materials and as a consequence environmental impact of the building in its construction and demolition phases may significantly increase.**

Study aimed to:

- 1) to perform a **detailed LCA** of energy efficient house, involving building's constructions and all engineering systems of the building;
- 2) to **apply and evaluate measures to reduce environmental impact** of the building during its life cycle;
- 3) to **assess influence of occupants' characteristics** (household size and age) and on life cycle of the building.

Methodology

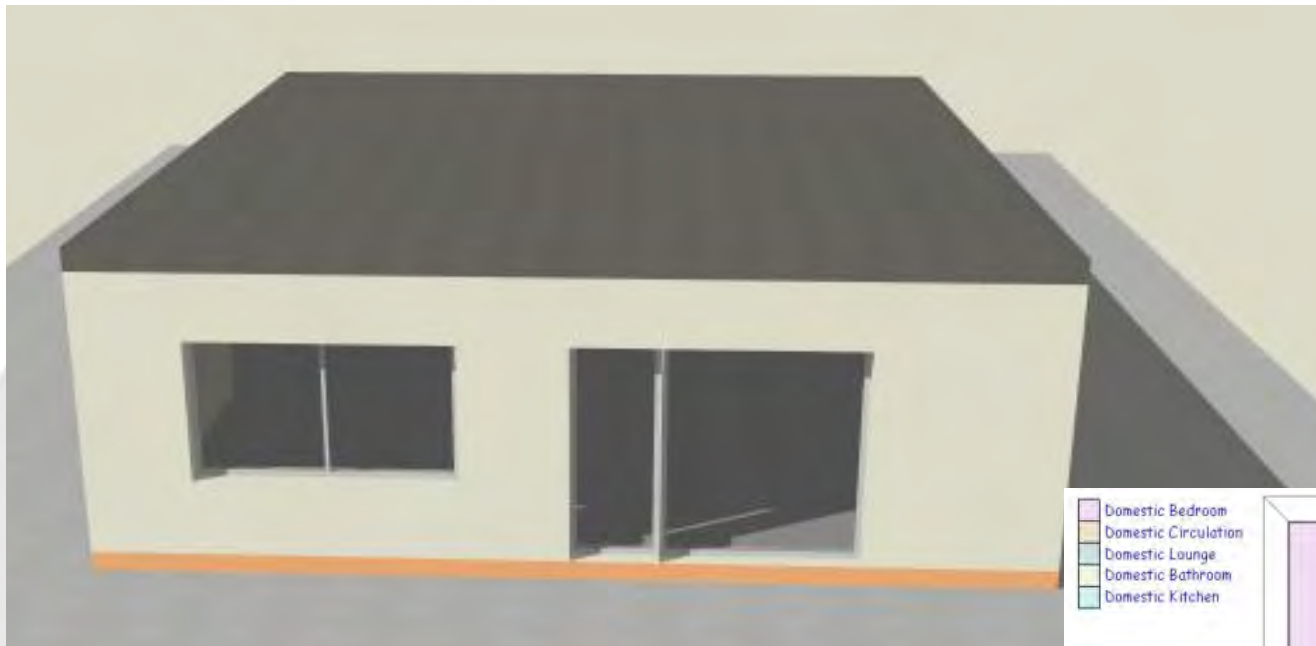
- Detailed LCA
- Dynamic building energy simulation

Environmental impact category	Indicator	Units
Primary energy demand	Non-renewable energy	MJ
Global warming	CO2 eq	kg
Ozone layer depletion	CFC-11 eq	kg

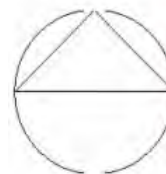


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Building



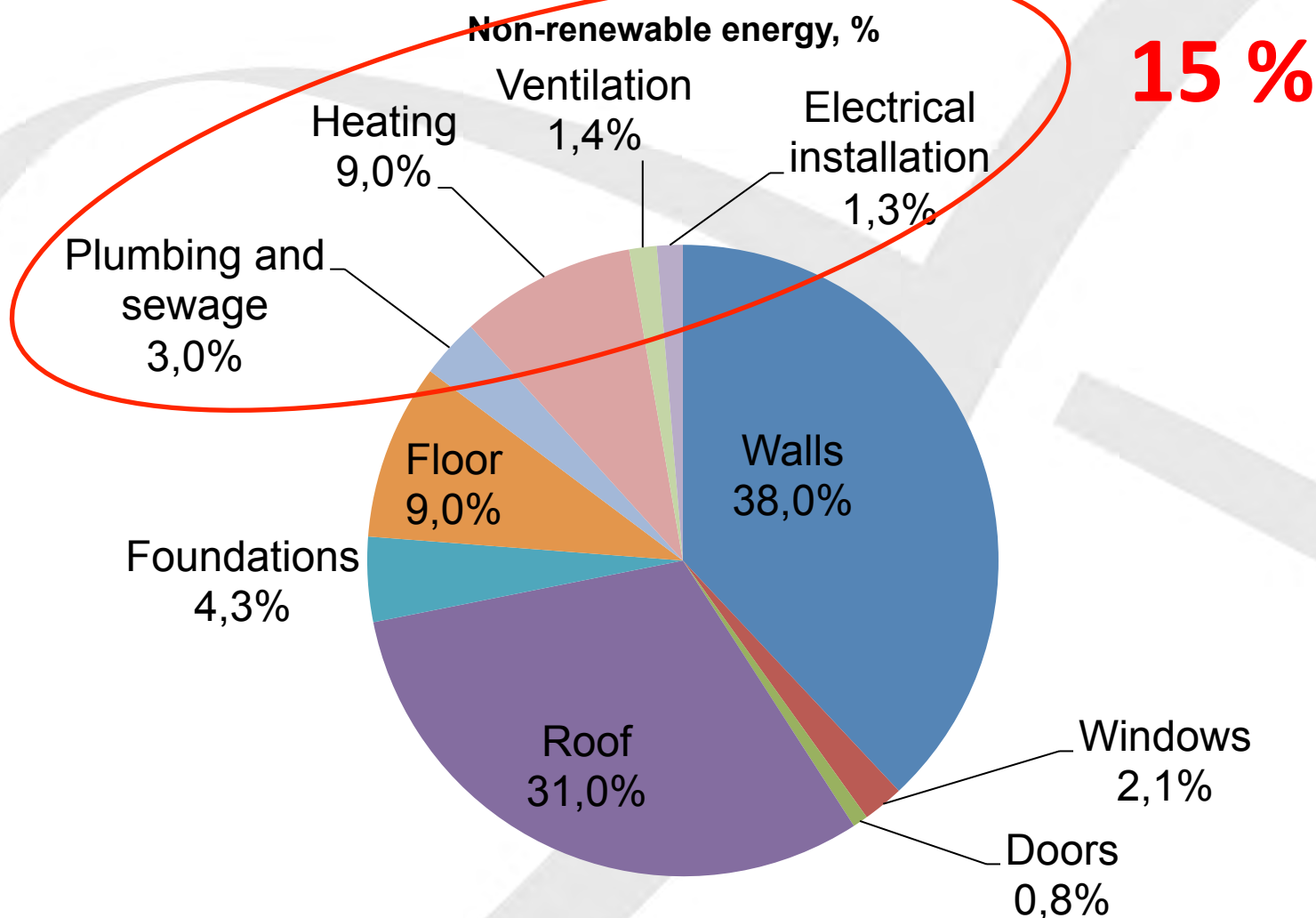
- Domestic Bedroom
- Domestic Circulation
- Domestic Lounge
- Domestic Bathroom
- Domestic Kitchen



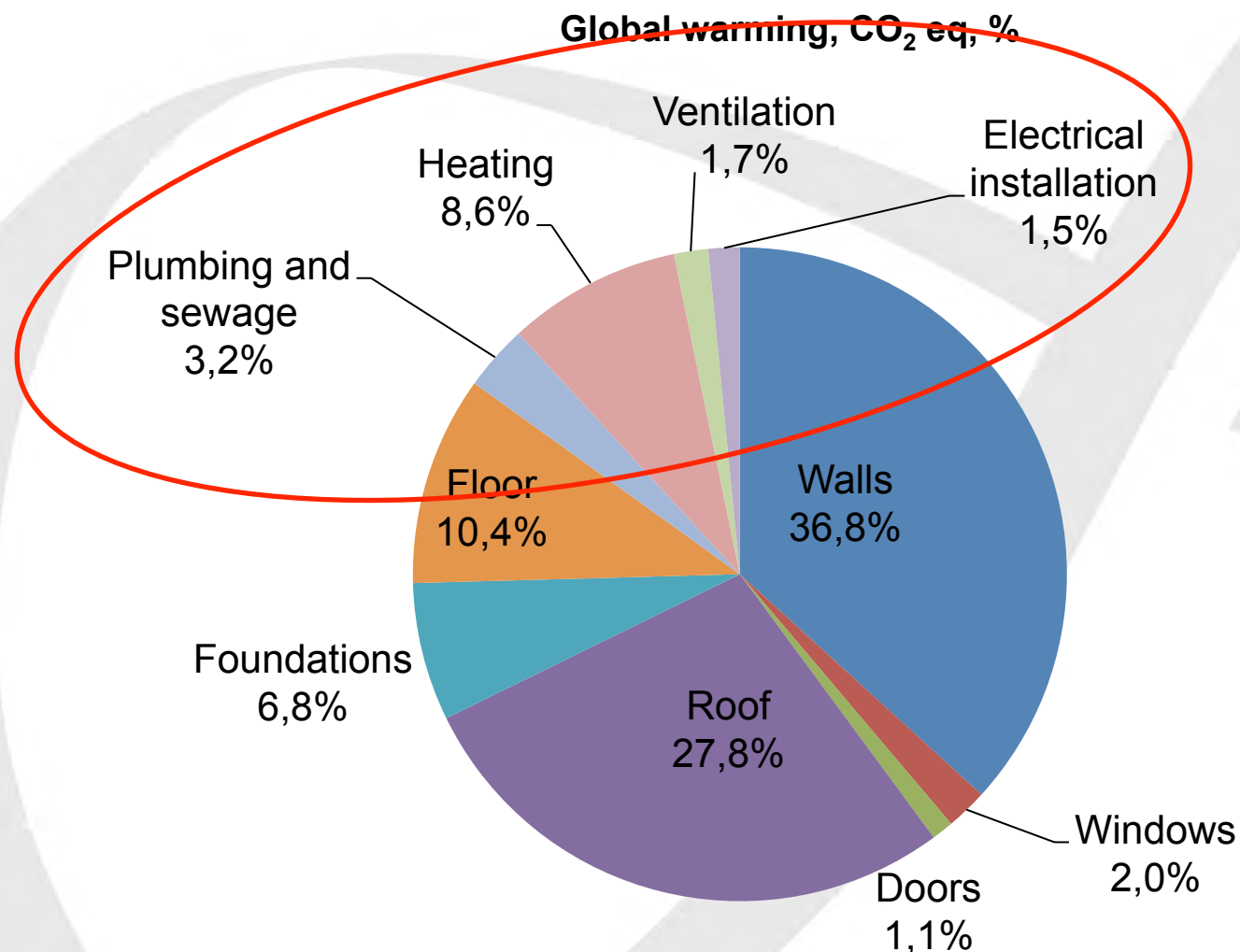
Assumptions

- The building will be used for over **100 years**;
- Calculating the **transportation phase**, **approximate distances** were chosen;
- Examining the materials of which separate elements were produced; a **very minor items were not included**.
- **Domestic electric appliances**, their energy demand **and furniture were not included** in the calculations.
- **The operational life span of separate elements** (replacement periodicity) was **estimated** according the national recommendations.

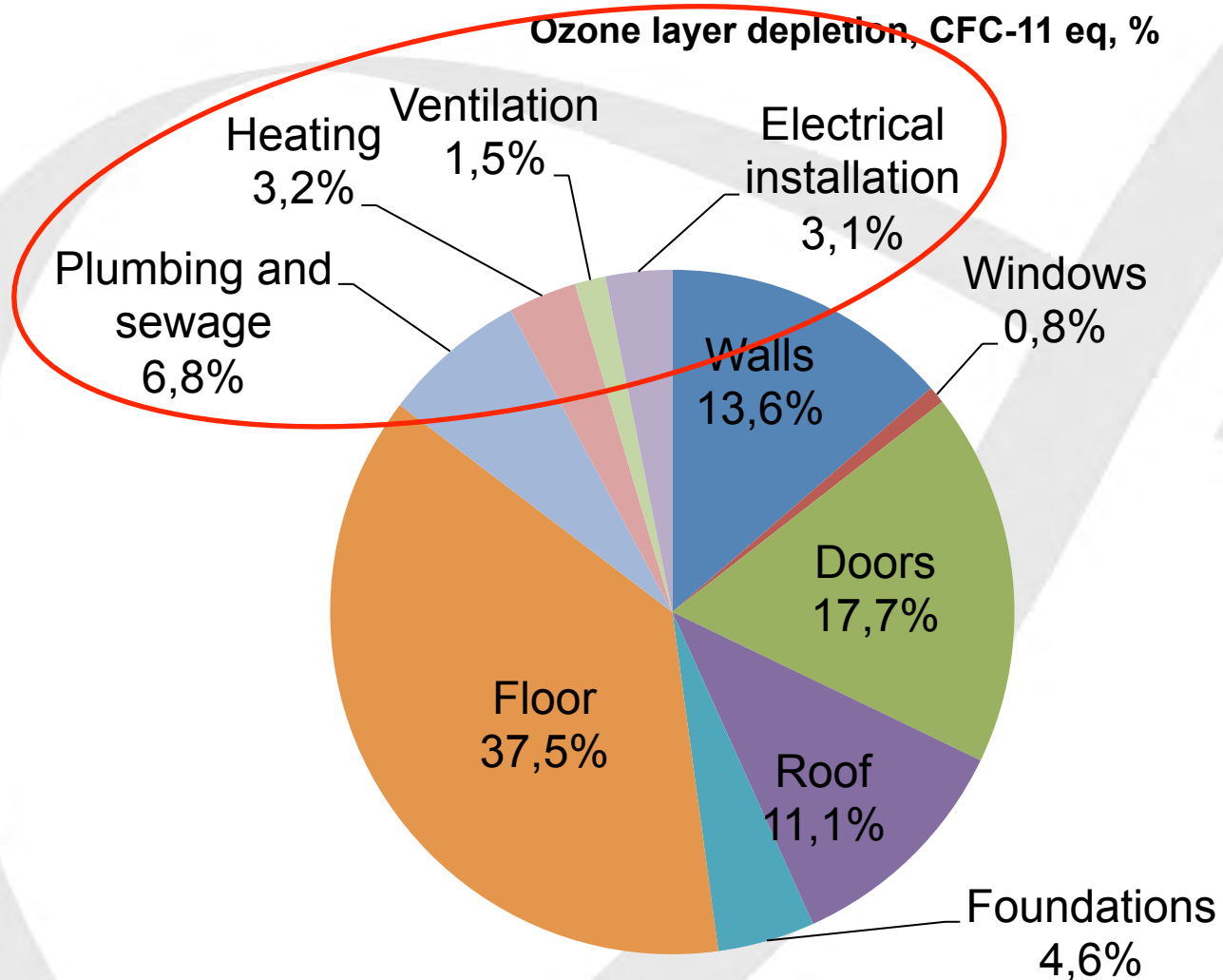
Embodied energy by the system/element



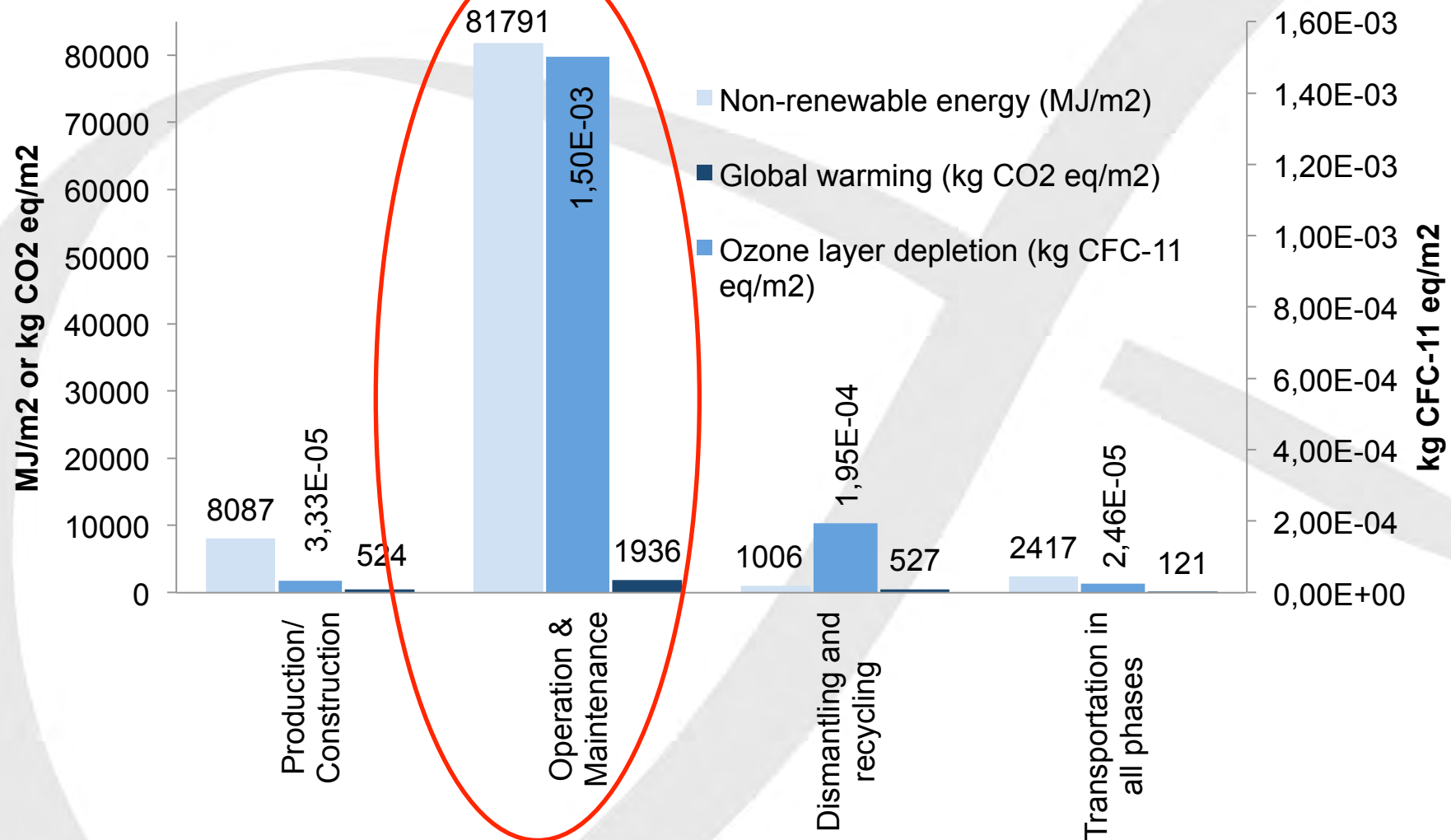
Embodied emissions by system/element



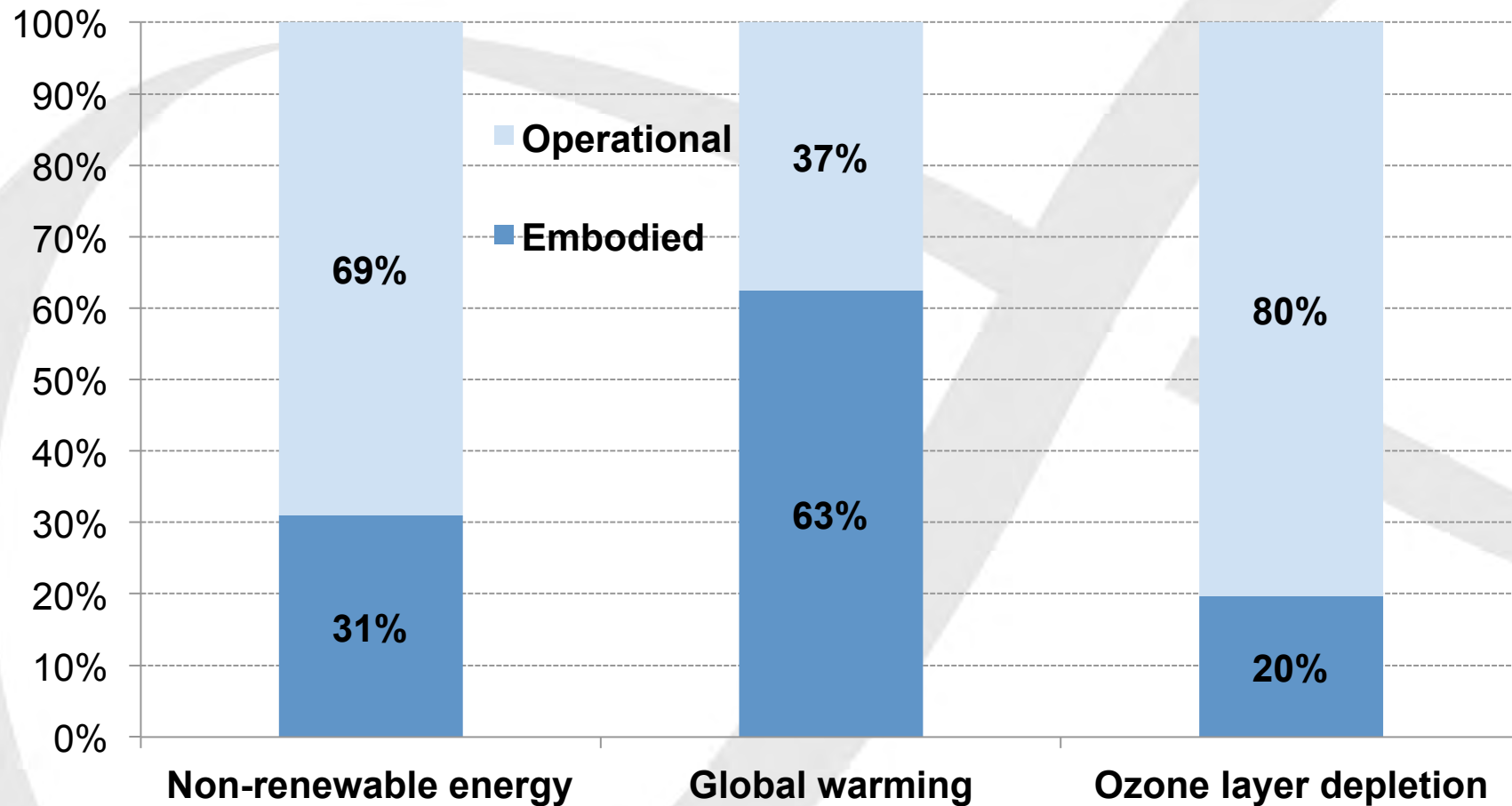
Embodied emissions by system/element



Impact of various life cycle phases



Operational vs embodied



Alternatives

Base case

Walls: silicate blocks,
polystyrene foam

Roof:

bitumen, MW stone
wool, EPS expanded
polystyrene, aerated
concrete roofing slab

Floor:

plywood flooring

Alternative 1

log walls with
rock wool
insulation

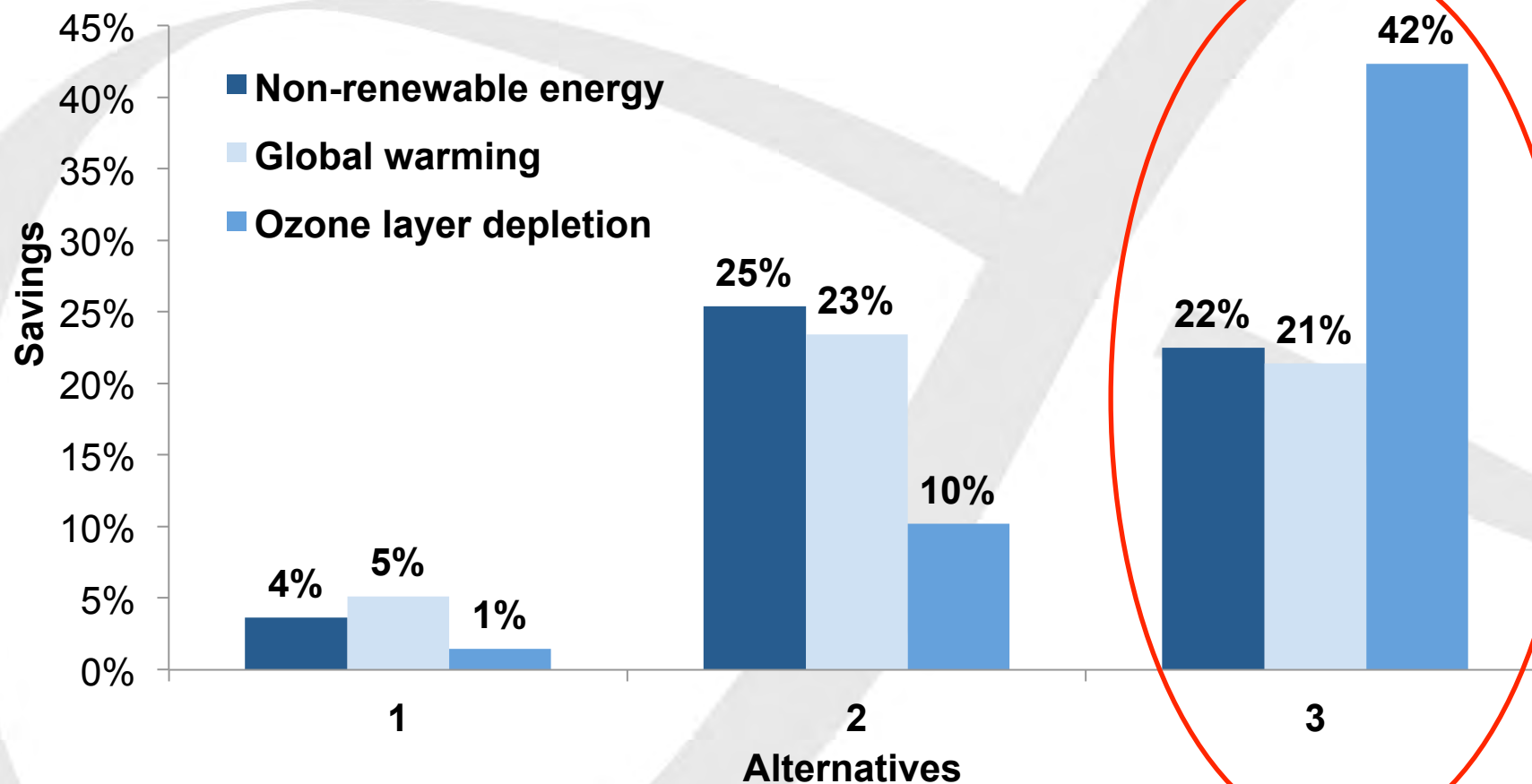
Alternative 2

Alternative 1 +
steel sheet roof
with rock wool
insulation

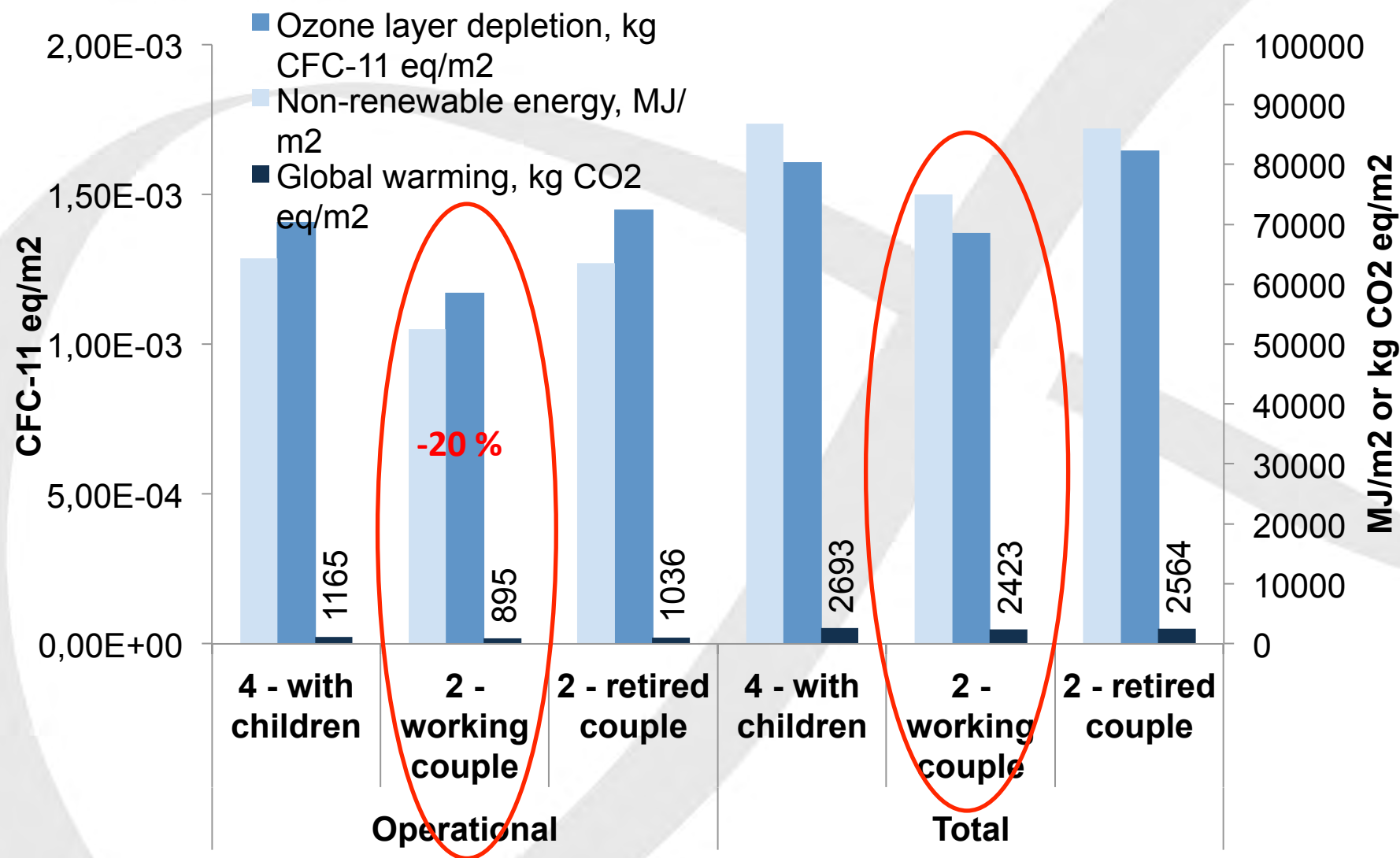
Alternative 3

Alternative 2 +
the second
alternative plus
new ceramic
tile floor

Evaluation of alternatives



Influence of occupancy



Conclusions

- For energy efficient houses environmental impact of the operational phase is decreasing, therefore **consideration of envelope construction materials becomes a key issue** for the design of sustainable building.
- **Technical systems have relatively minor embodied environmental impact and improvement potential.** Nevertheless, just complex detailed optimisation of the embodied and operational energy and emissions enables to get the best result.

Concluussions

- Household size and age influences environmental impact categories, but it **might be considered as insignificant** if the size of household and age of occupants is changing during life cycle of the building. Therefore, when performing dynamic LCA, **analysis of these factors might be inexpedient**.
- There are still cases, when **it might be important to take into account occupant's characteristics**, e. g. students' hostels cannot be calculated as standard family houses, because such specific buildings have always the same occupants.



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Thank you!
Questions?

Danke schön!
Fragen?