Environmental perspective on two glazing typologies

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Objective

- Comparison of two glazing technologies (triple-glazing with argon and double-glazing with aerogel).
- Comparison of three glazing ratios (24%, 33%, and 50%).
- Application to the East and West facades of a residential block in Oslo (Myhrerenga Borettslag).
- Analysis of the yearly energy demand and greenhouse gas emissions.

Illustration: Sintef Byggforsk

Objective

Variation of the glazing ratio:

- 24%
- 33%
- 50%

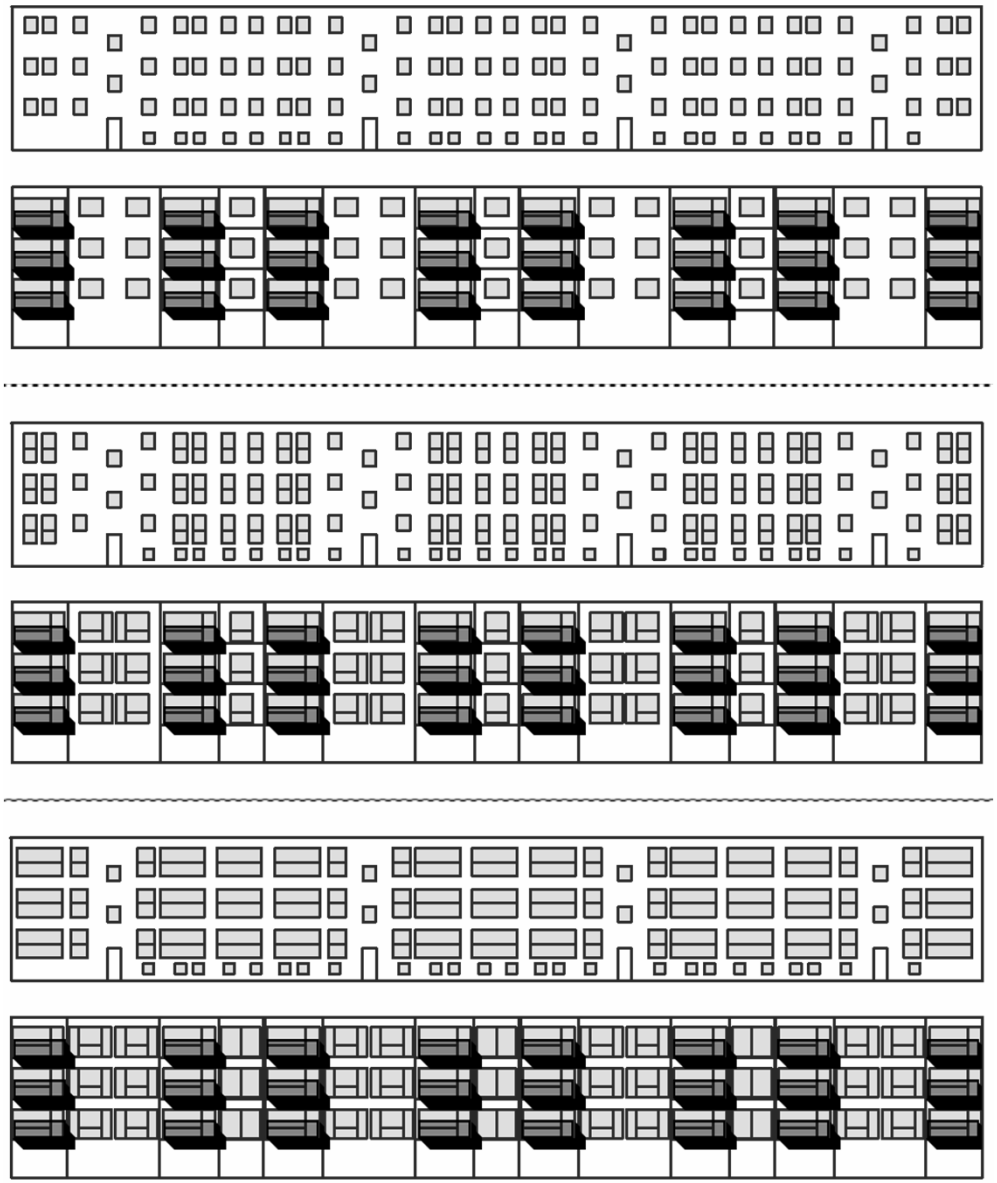


Illustration: Nicola Lolli

Method

Current renovation of the Myhrerenga Borettslag as reference building (façade U-value 0.12 $Wm^{-2}K^{-1}$, 24% glazing ratio, triple-glazing with argon).

Proposed upgrades with **triple-glazing with argon:**
façade U-value 0.10 $Wm^{-2}K^{-1}$, 24%, 33%, and 50% glazing ratio

Proposed upgrades with **double-glazing with aerogel:**
façade U-value 0.10 $Wm^{-2}K^{-1}$, 24%, 33%, and 50% glazing ratio

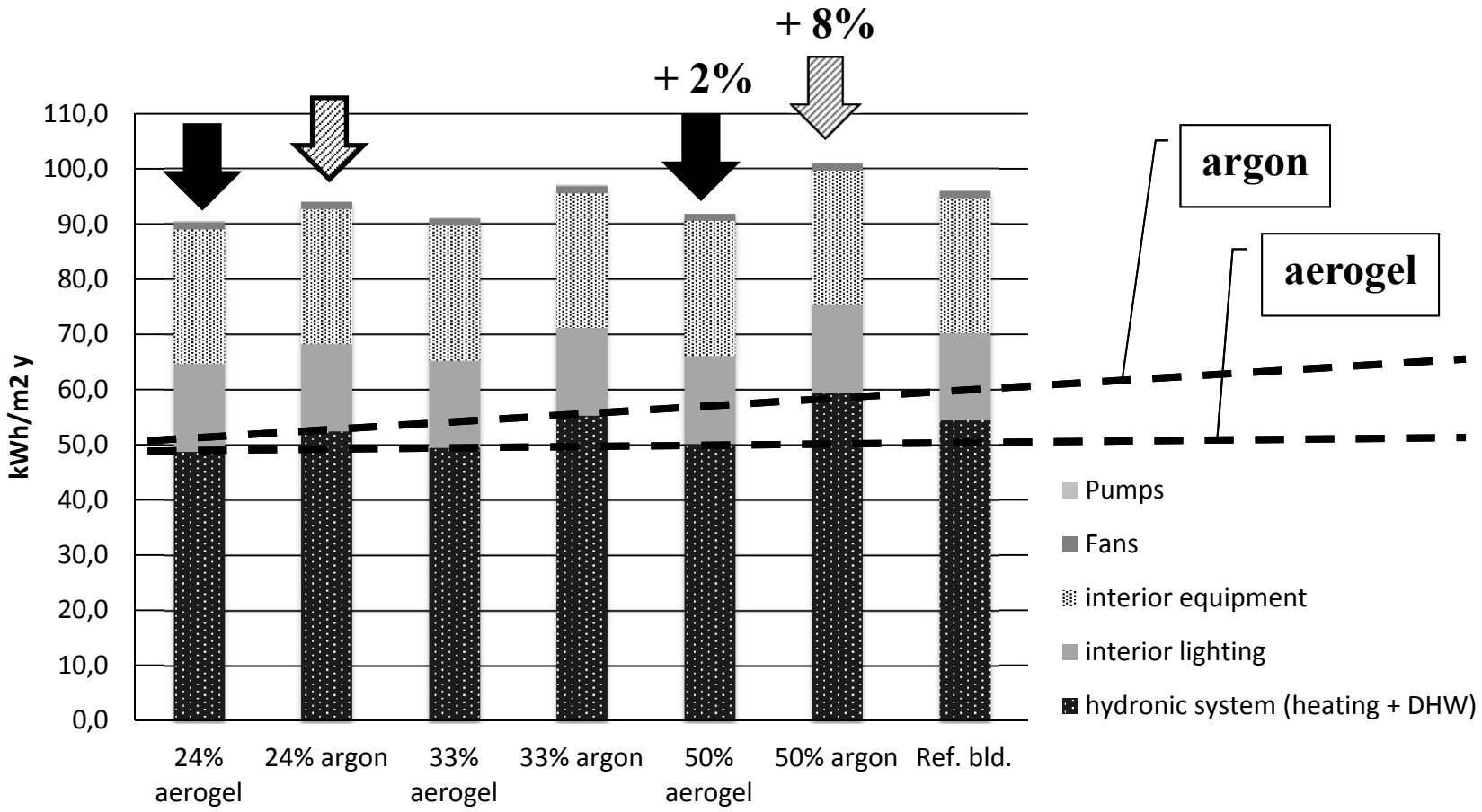
Triple-glazing with argon: U-value 0.79 $Wm^{-2}K^{-1}$
Double-glazing with aerogel: U-value 0.50 $Wm^{-2}K^{-1}$

Share of aerogel glazing: for 24% and 33% glazing ratio: **28%** aerogel.
for 50% glazing ratio: **39%** aerogel.

Method

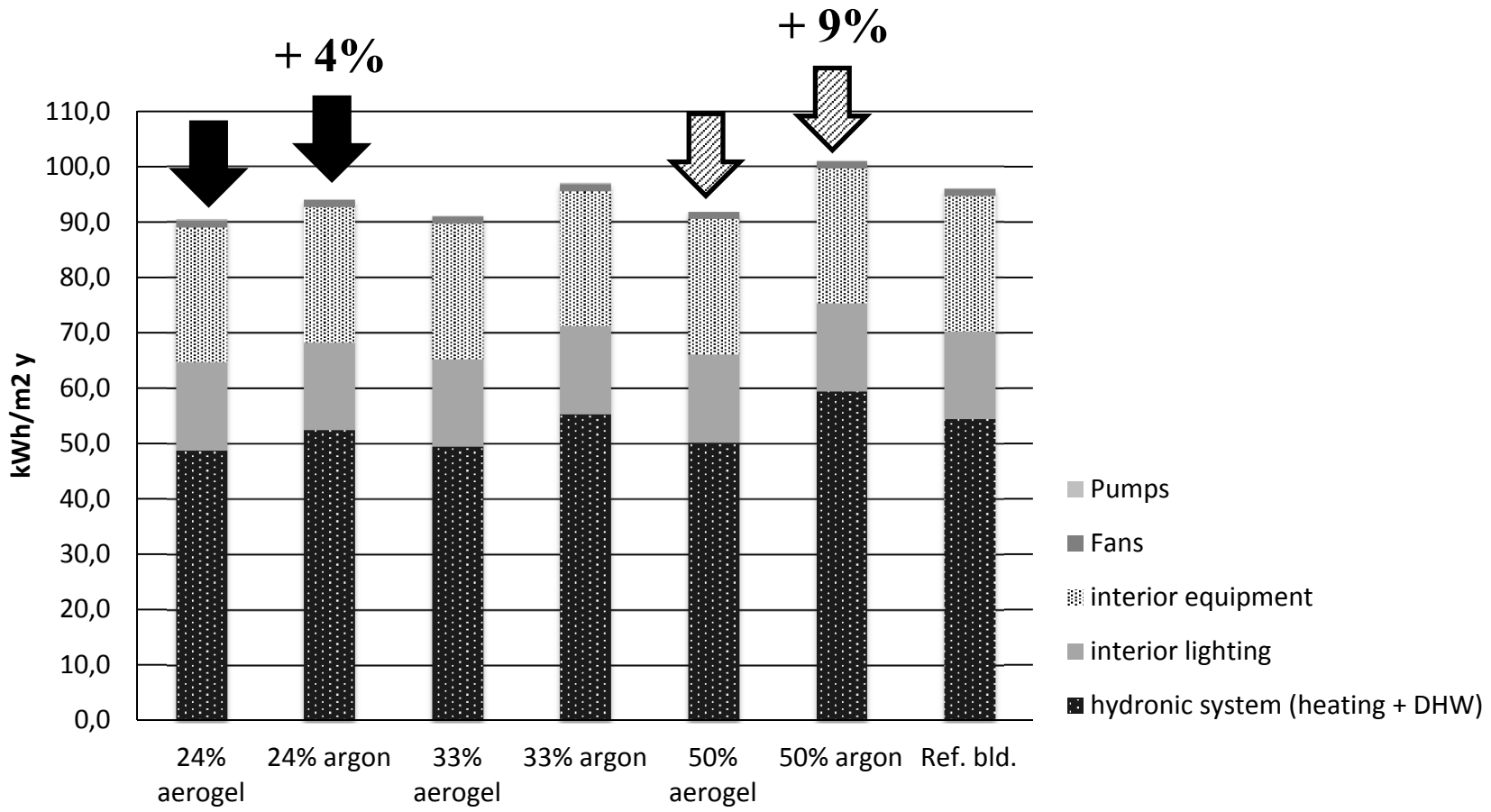
- Phases of the life cycle model : production, transportation, building use, maintenance, and end-of-life.
- Building lifetime set to 50 years.
- Variation of maintenance schedules for glazing: long (**50** yrs), short (**20** yrs), and supershort (**10** yrs, only for aerogel glazing).
- ZEB conversion factor = **0.152** $kgCO_{2\text{-}eq}kWh^{-1}$

Yearly building energy demand



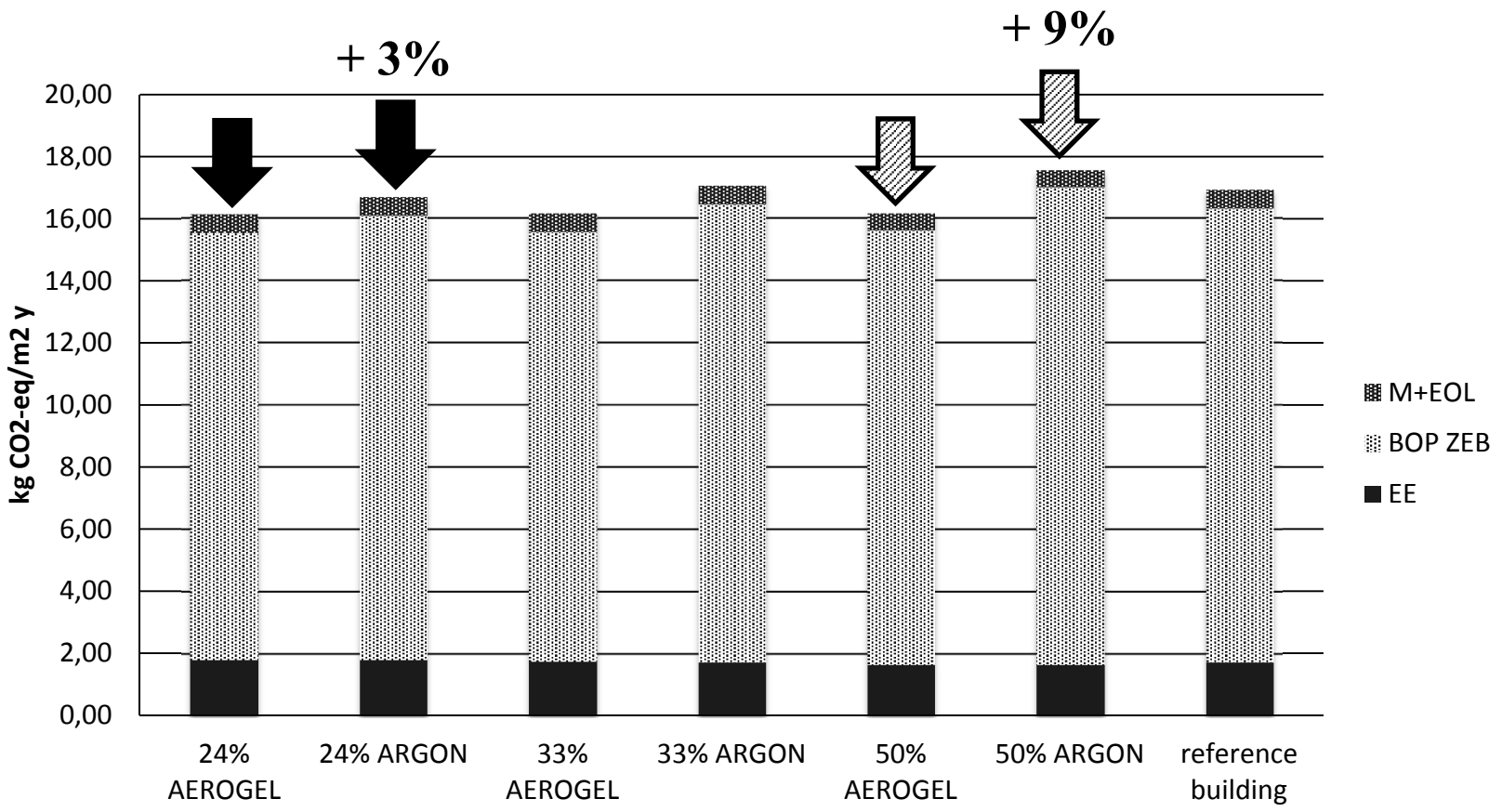
- Total energy use of *50% argon* is 8% higher than of *24% argon*
- Total energy use of *50% aerogel* is 2% higher than of *24% aerogel*

Yearly building energy demand



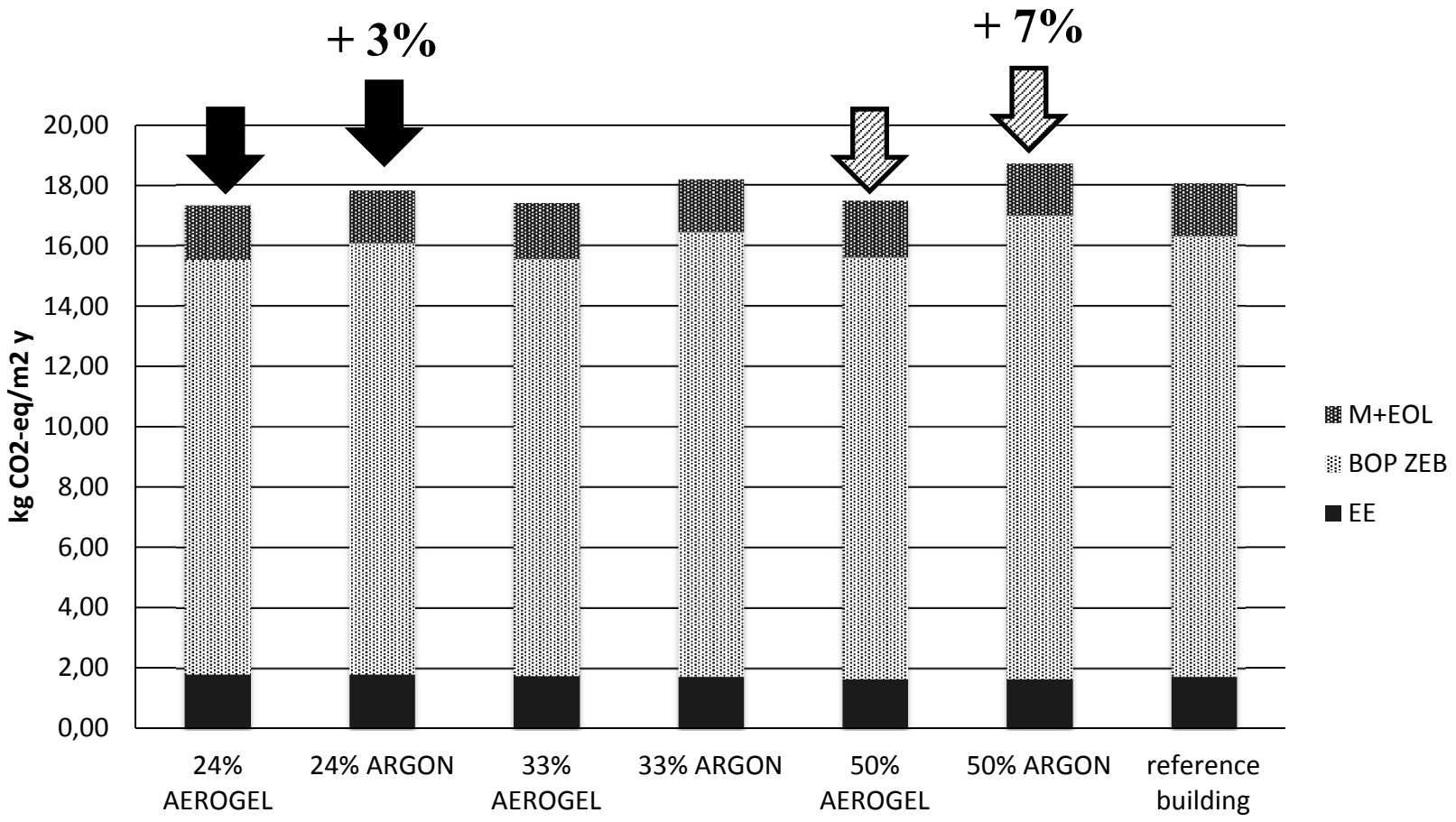
- Total energy use of *24% argon* is 4% higher than of *24% aerogel*
- Total energy use of *50% argon* is 9% higher than of *50% aerogel*

Life cycle emissions (long maintenance)



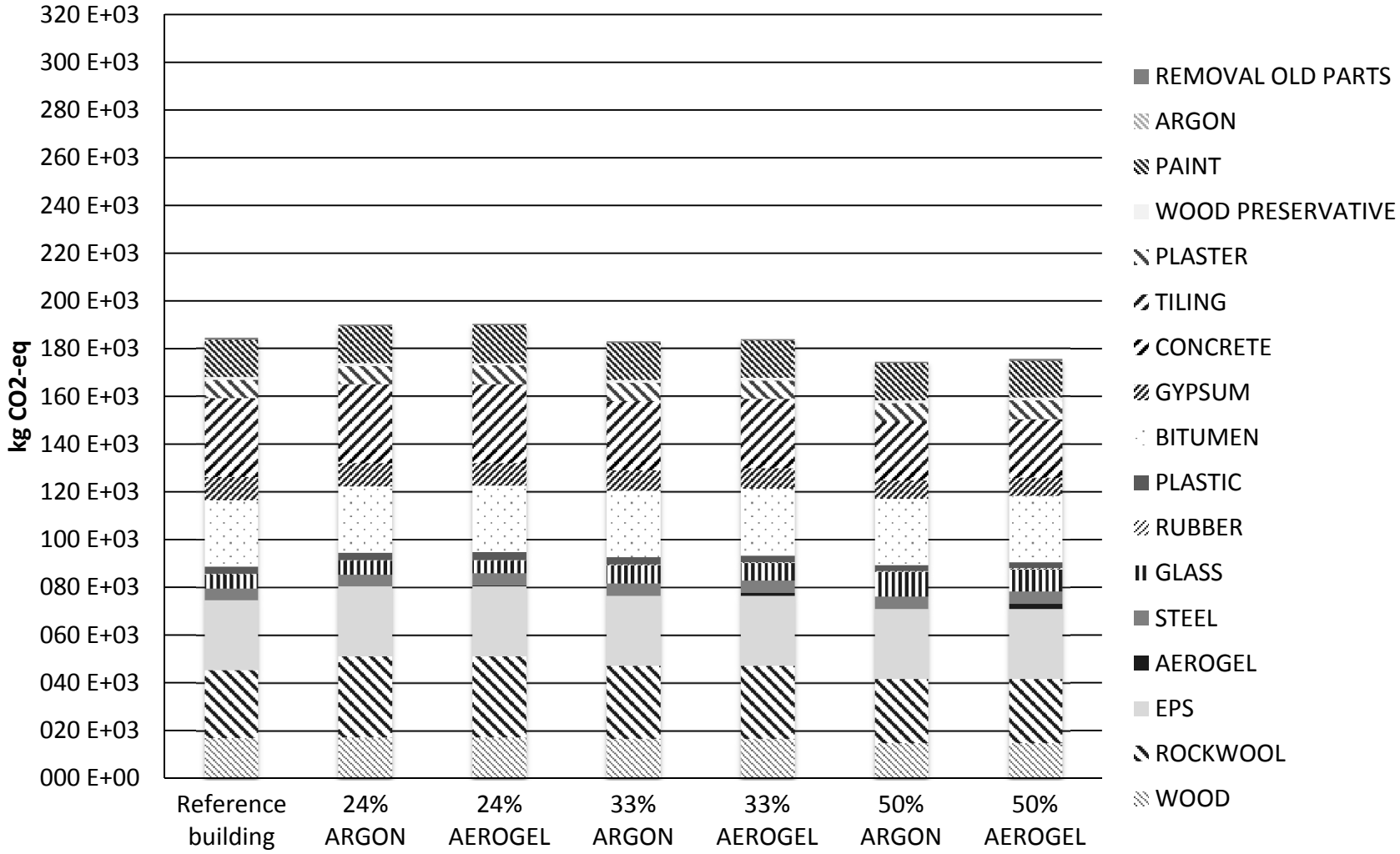
- Total emissions of *24% argon* are 3% higher than of *24% aerogel*
- Total emissions of *50% argon* are 9% higher than of *50% aerogel*

Life cycle emissions (supershort maintenance)

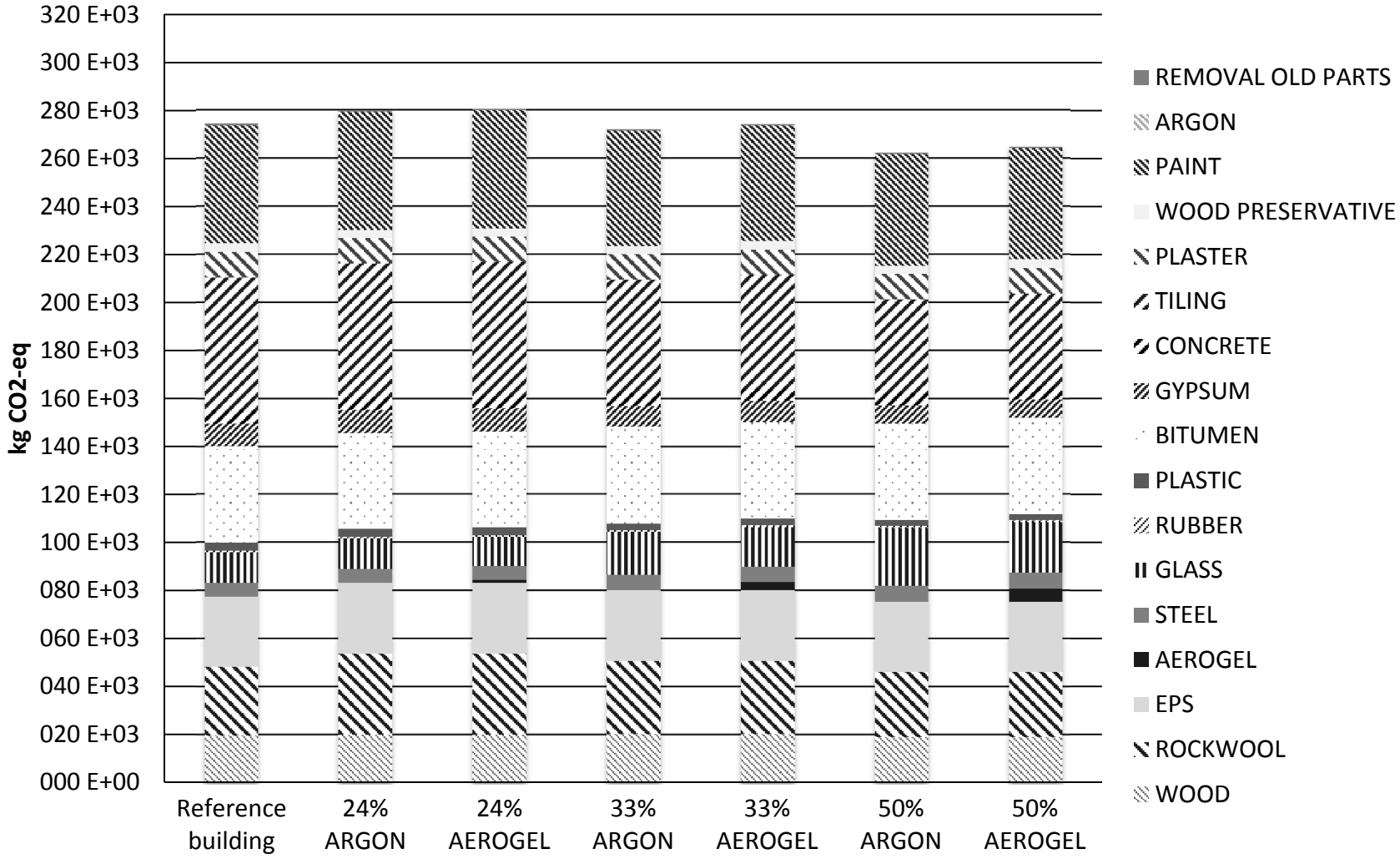


- Total emissions of *24% argon* are 3% higher than of *24% aerogel*
- Total emissions of *50% argon* are 7% higher than of *50% aerogel*

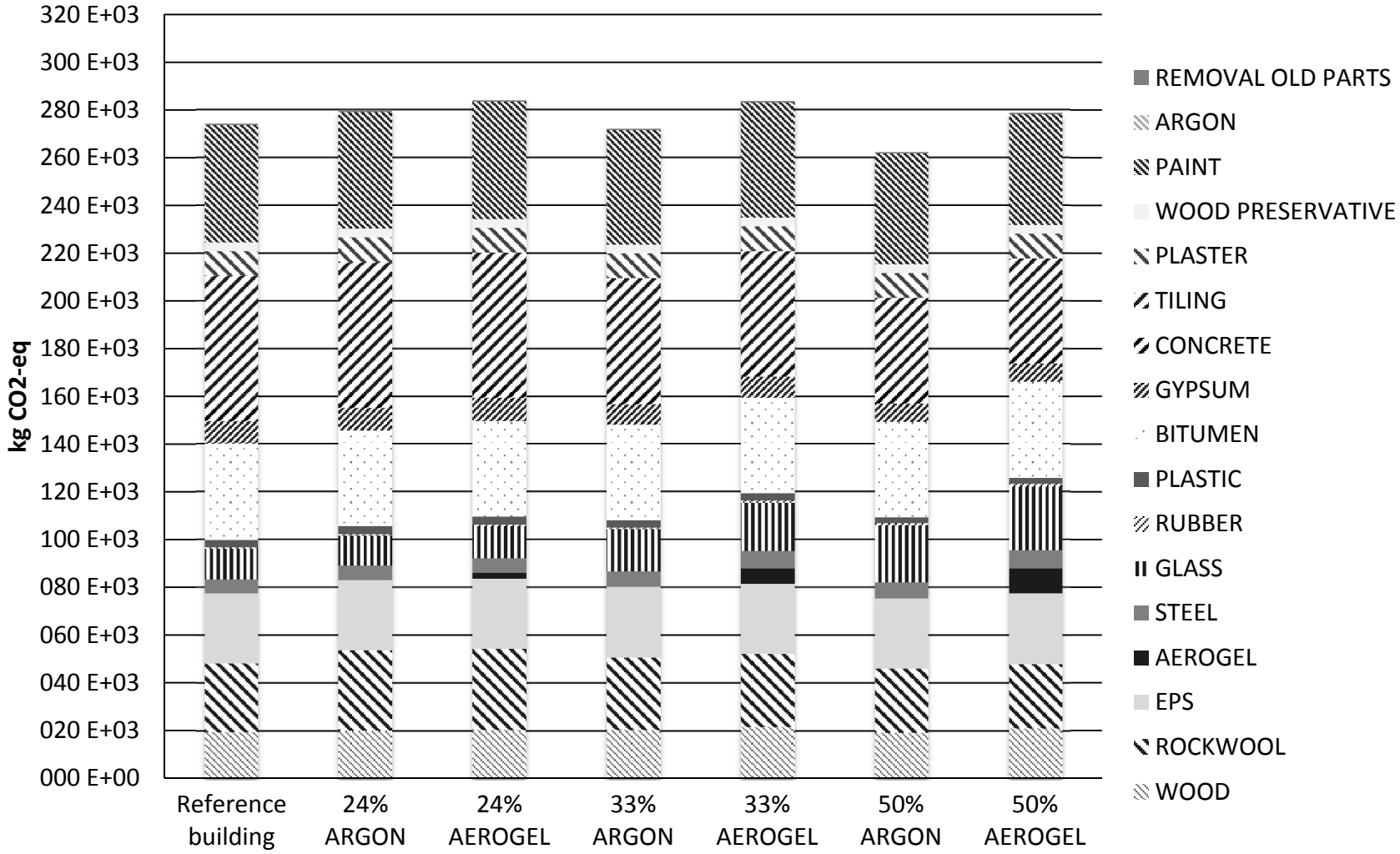
Embodied emissions - long maintenance



Embodied emissions - short maintenance



Embodied emissions - supershort maintenance



Limitations

Uncertainty of results due to:

- No known data of service life of aerogel glazing.
- No known data of disposal scenario of aerogel (assumed as landfilling).
- Little emissions data for aerogel.

- Embodied emissions for the assembling of the glazing technologies is not calculated.
- Embodied emissions for the transportation of the maintenance workers is not calculated.

Variation of the building orientation is expected to change the results.

A different electricity-to-emissions conversion factor is expected to give different results.

Summing up

- The embodied emissions decrease when the glazing ratio increases (maximum 8% difference).
- Emissions for paint and concrete tiling are maximum 38% of the total (for short maintenance).
- Emissions for glass and aerogel are maximum 9% of the total (for supershort maintenance).
- The glazed part of the facades has lower emissions than the opaque part, per unit of surface.

Conclusions

- **Lifecycle emissions**: double-glazing with aerogel has always lower emissions than triple-glazing with argon, regardless of the maintenance schedule.
- **Embodied emissions**: double-glazing with aerogel result in higher emissions than triple-glazing with argon for a short maintenance schedule.
- With longer maintenance both glazing technologies have lower and similar embodied emissions.
- The choice of maintenance schedule (given by quality of materials) is critical.
- A future greener energy grid would make the aerogel glazing technology not competitive, regardless of the maintenance schedule.

NTNU

Thank you!