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Greenhouse gas analysis of insulation options in residential energy retrofitting

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Objective

- Comparison of three insulation materials (mineral wool, VIP, aerogel).
- Application to the facades of a residential block in Oslo (Myhrerenga Borettslag).
- Analysis of the yearly energy demand and greenhouse gas emissions.

Illustration: Sintef Byggforsk

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Method

- Current renovation of the Myhrerenga Borettslag as reference building (façade U-value 0.12 $Wm^{-2}K^{-1}$ and mineral wool 200 mm).
- Proposed upgrades with **mineral wool** (250 mm), **aerogel** (100 mm), and **VIP** (60 mm). Façade U-value for each = 0.10 $Wm^{-2}K^{-1}$.
- Indoor environmental controls set as in NS 3700:2010 and NS 3031:2007.
- Indoor temperature is 21 C / 19 C for occupied/unoccupied.

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Method

- Life cycle model covers the phases: production, transportation, building use and maintenance, and end-of-life.
- Building lifetime set to 50 years. Variation to 25 and 75 years.
- Variation of the electricity-to-emissions conversion factor:
    - European average (**0.361** $kgCO_{2-eq}kWh^{-1}$)
    - ZEB (between **0.303** and **0.101** $kgCO_{2-eq}kWh^{-1}$)
    - Norwegian inland production (**0.019** $kgCO_{2-eq}kWh^{-1}$).

AGH1

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AGH1 Anne Grete Hestnes; 2013-10-03

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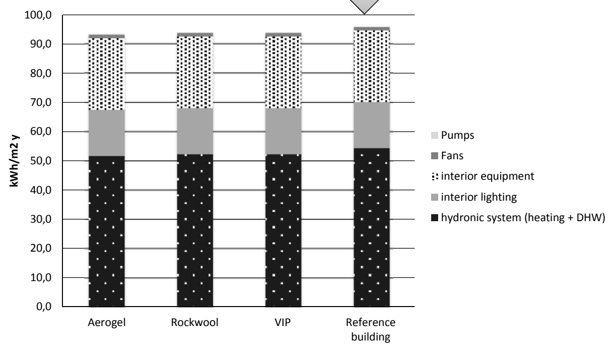
Energy demand



- The reference building uses 2 kWhm^{-2}y^{-1} more energy than the other cases.
- Space heating and DHW of the reference building is 5% higher than the other alternatives.

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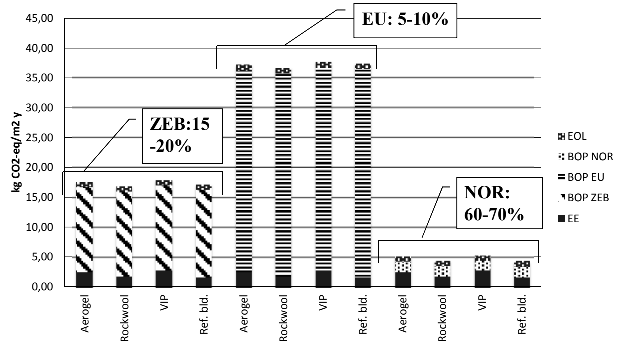
Lifecycle emissions over 50 years



- The share of EE and EOL when using the ZEB factor is 15-20%.
- The share of EE and EOL when using the EU factor is 5-10%.
- The share of EE and EOL when using the NOR factor is 60-70%.

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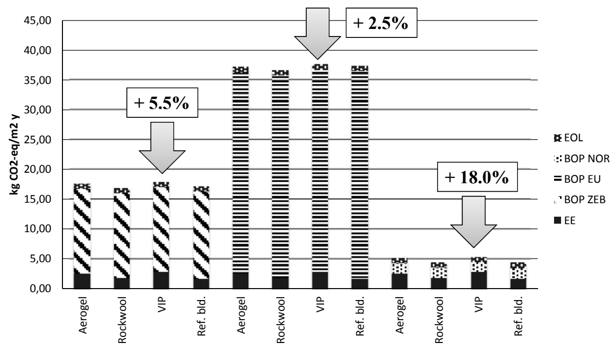
Lifecycle emissions over 50 years



VIP: 5.5% higher emissions than for rockwool when using the ZEB factor
2.5% higher emissions than for rockwool when using the EU factor
18.0% higher emissions than for rockwool when using the NOR factor

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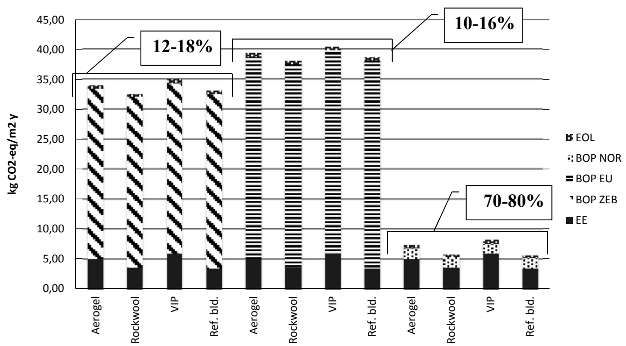
Lifecycle emissions over 25 years



- The share of EE and EOL when using the ZEB conversion factor is 12-18%.
- The share of EE and EOL when using the EU conversion factor is 10-16%.
- The share of EE and EOL when using the NOR conversion factor is 70-80%.

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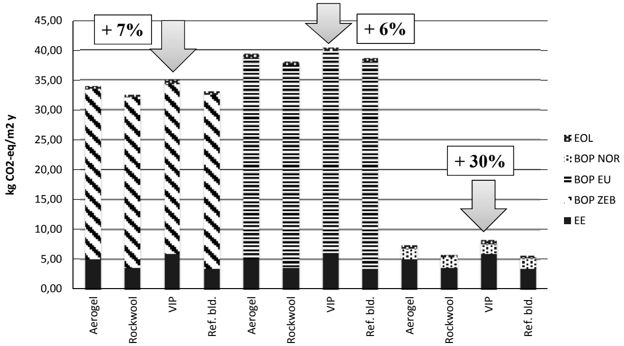
Lifecycle emissions over 25 years



VIP: 7% higher emissions than for rockwool when using the ZEB factor.
6% higher emissions than for rockwool when using the EU factor.
30% higher emissions than for rockwool when using the NOR factor.

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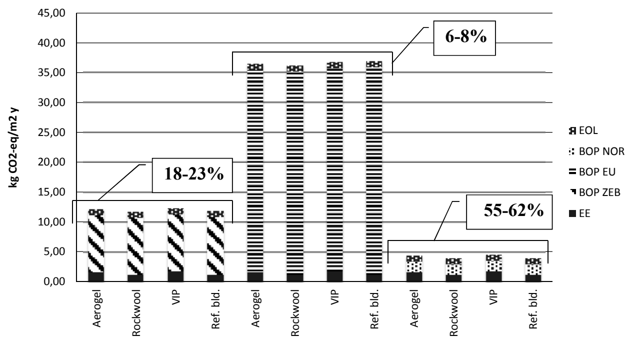
Lifecycle emissions over 75 years



- The share of EE and EOL when using the ZEB conversion factor is 18-23%.
- The share of EE and EOL when using the EU conversion factor is 6-8%.
- The share of EE and EOL when using the NOR conversion factor is 55-62%.

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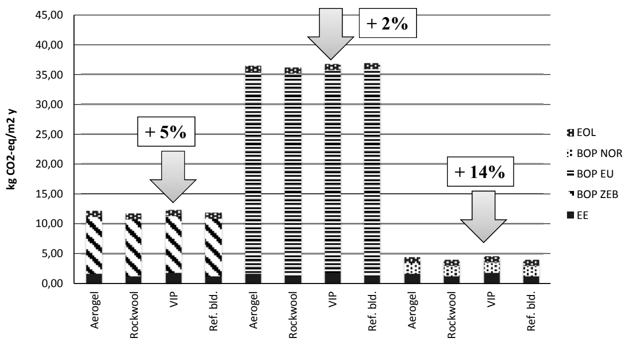
Lifecycle emissions over 75 years



VIP: 5% higher emissions than for rockwool when using the ZEB factor.
2% higher emissions than for rockwool when using the EU factor.
14% higher emissions than for rockwool when using the NOR factor.

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Summing up

- A longer lifetime reduces the differences between the alternative insulation types, regardless of the conversion factor.
- The ZEB factor results in stable differences (maximum 7%-5%).
- The EU factor results in small differences (maximum 6%-2%).
- The NOR factor results in the highest differences (maximum 30%-14%).
- Using more rockwool only reduces the emissions by a maximum of 2% compared to the emissions of the reference building.

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Conclusions

- Aerogel and VIP result in higher lifetime emissions when using the CO_2 electricity-to-emissions conversion factor based on inland production of electricity (NOR).
- The choice electricity-to-emissions conversion factor is critical.
- For a lifetime longer than 75-years the use of aerogel, VIP, or rockwool would produce the same results.

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Nicola Lolli. First Year Hearing. 23.11.10

Thank you!

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