Cool roofing in cold climates
A contradiction or a potential for energy savings?

ZEB WP1 - Task 1.2 - Activity 1.9
Solar Reflectance/ Solar Absorptivity

Solar Reflectances for various building components
Which color shall we choose?

Concrete Roofing Tiles

Increasing Solar Reflectance

Fig. 2. Concrete tile prototypes arranged by solar reflectance.
Answer

- That depends upon what building you are analyzing and the relative importance between heating and cooling - the local climate.
  - Small house
  - Apartment Building
  - Office with high internal heat gains
Where did we start?

- Investigated the thermal performance of a compact roof
  - WUFI simulations
  - Comsol simulations
  - TRNSYS
WUFI v4

Low reflectance (black) roofing temperature plot (absorption coefficient $\alpha = 0.8$)
High reflectance (white) roofing temperature plot (absorption coefficient $\alpha = 0.2$)
Comsol Multiphysics

Steady state temperature distribution with -2.5°C outdoors and 20°C indoors. The heat flux is represented by arrows.
15th March - Trondheim

Heat Flux Magnitude through the external surface boundary

Transmission Heat Loss [W/m²]

Time of Day [h]

Solar Absorptivity

- 0
- 0.25
- 0.5
- 0.75
- 1
Summer Peak

Temperature development of the indoor surface, interface between the concrete and insulation, and outdoor surface during 24 hours using solar data extracted from TRNSYS for the 15th July in Trondheim.
Outdoor surface temperature with solar absorptivity = 0.9 and 0.1
TRNSYS

Indoor surface temperature with solar absorptivity = 0.9 and 0.1
Energy Savings Potential

- To investigate the energy savings potential of cool roofs, the top floor of an office building was simulated with TRNSYS using the minimum component requirements according to TEK10 building codes.

- The windows, roof, and walls had U-values 1.2, 0.18, and 0.22 W/m²K respectively. The internal heat gains were simulated first with 30 W/m² and then with 40 W/m².

- More than adequate heating and cooling was installed in order to maintain the indoor temperature between 19 and 25 degrees all year round.

- The window to wall ratio was 20%, the total floor area was 1200 m², and the floor to ceiling height was 2.5 meters.

- Trondheim, Norway Weather Climate
## Energy Savings Potential

<table>
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<tr>
<th>Solar Abs.</th>
<th>Heating</th>
<th>Cooling</th>
<th>Total</th>
<th>Heating</th>
<th>Cooling</th>
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Comparison with LA

- For comparison, the building was also simulated with only 5 cm insulation in the roof while being located in the hot climate of Los Angeles.

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- Energy savings potential of 8.6 kWh/m² relative the black surface.
Conclusion

• In a Nordic climate, as the internal heat gains increase to 40 W/m², a cool roof has only a marginal energy savings potential.
Thanks for Listening

• Any Questions ???