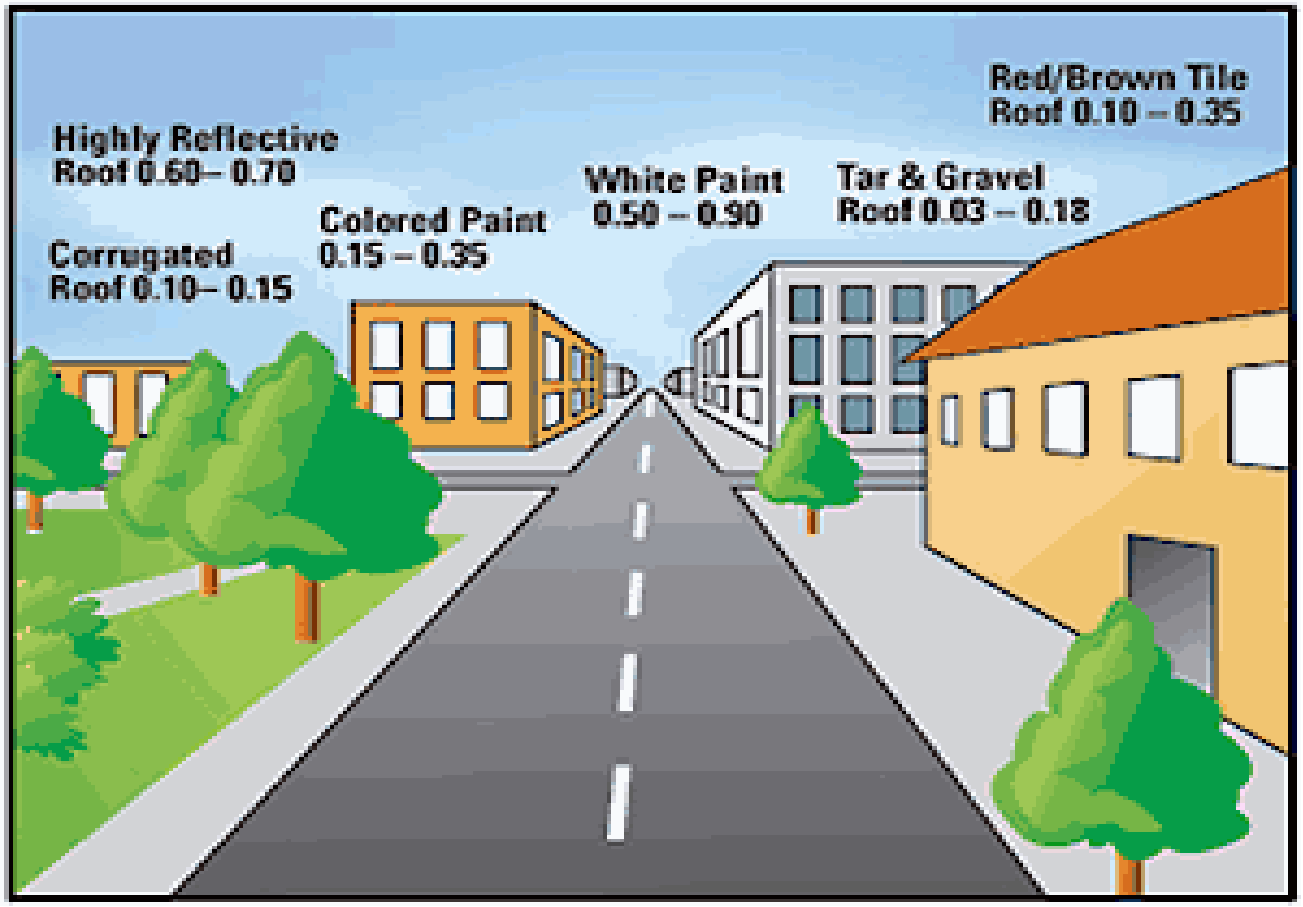
Cool roofing in cold climates

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?

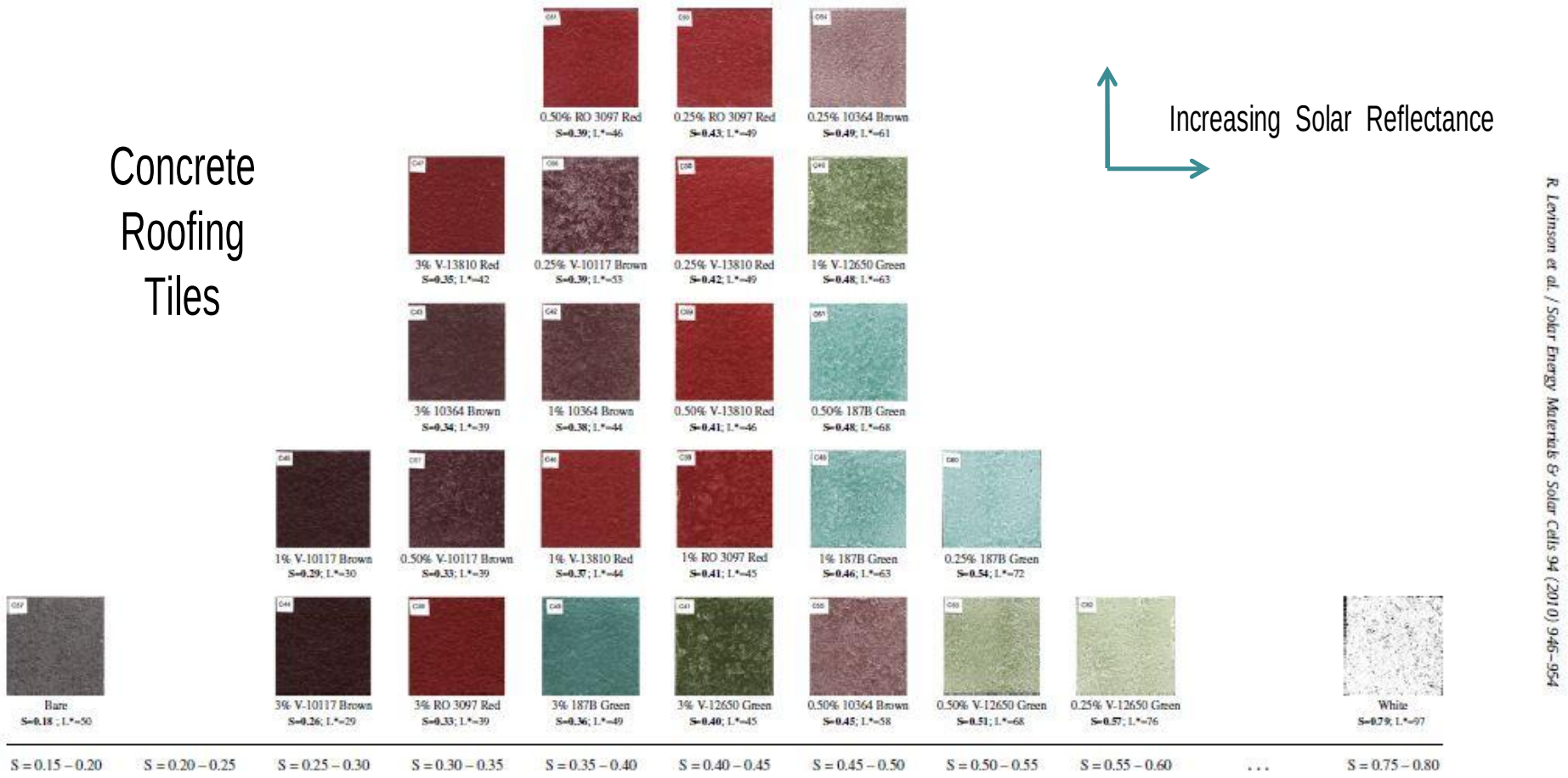


Fig. 2. Concrete tile prototypes arranged by solar reflectance.

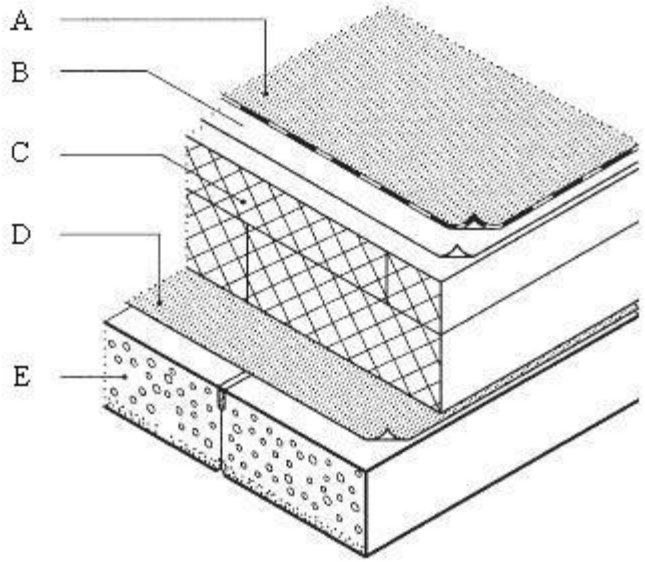
R. Levinson et al. / Solar Energy Materials & Solar Cells 94 (2010) 946–954

Answer

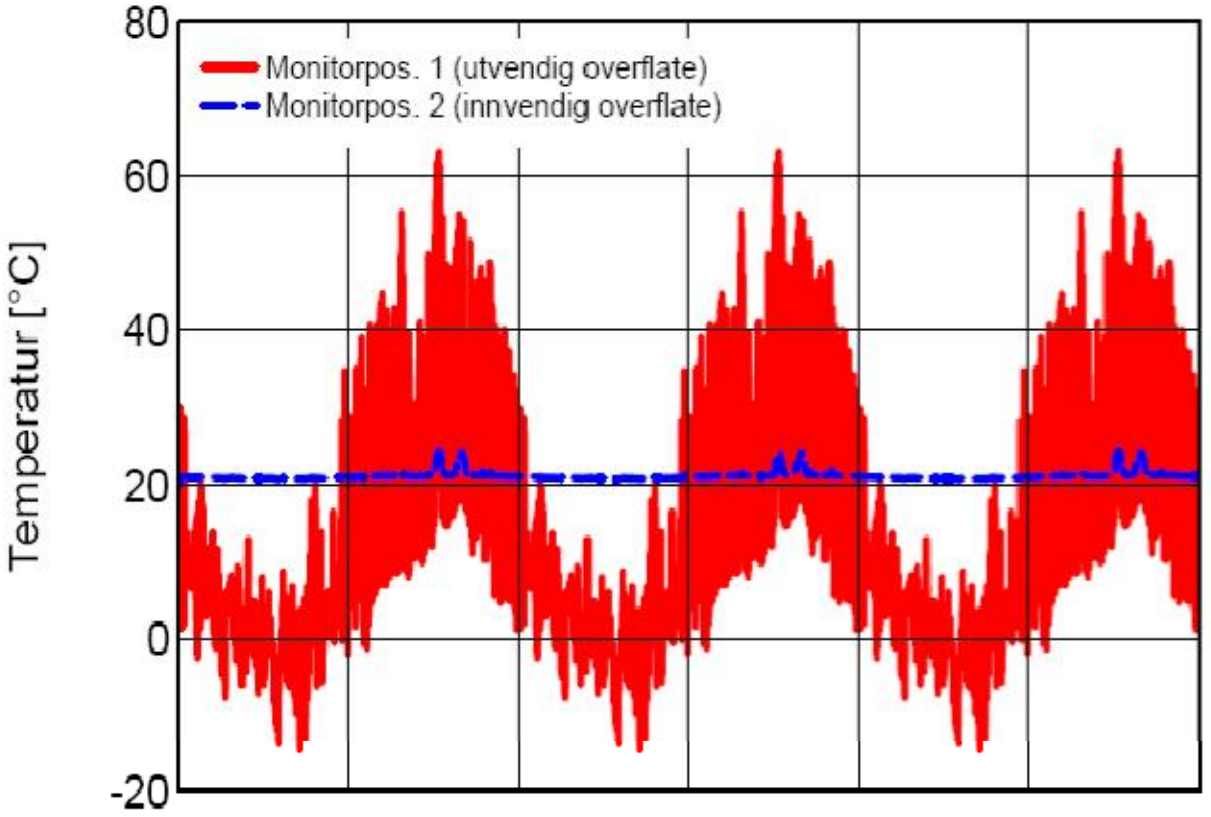
- That depends upon what building you are analyzing and the relative importance between heating and cooling – the local climate.
  - Small house
  - Apartment Building
  - Office with high internal heat gains

Where did we start?

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

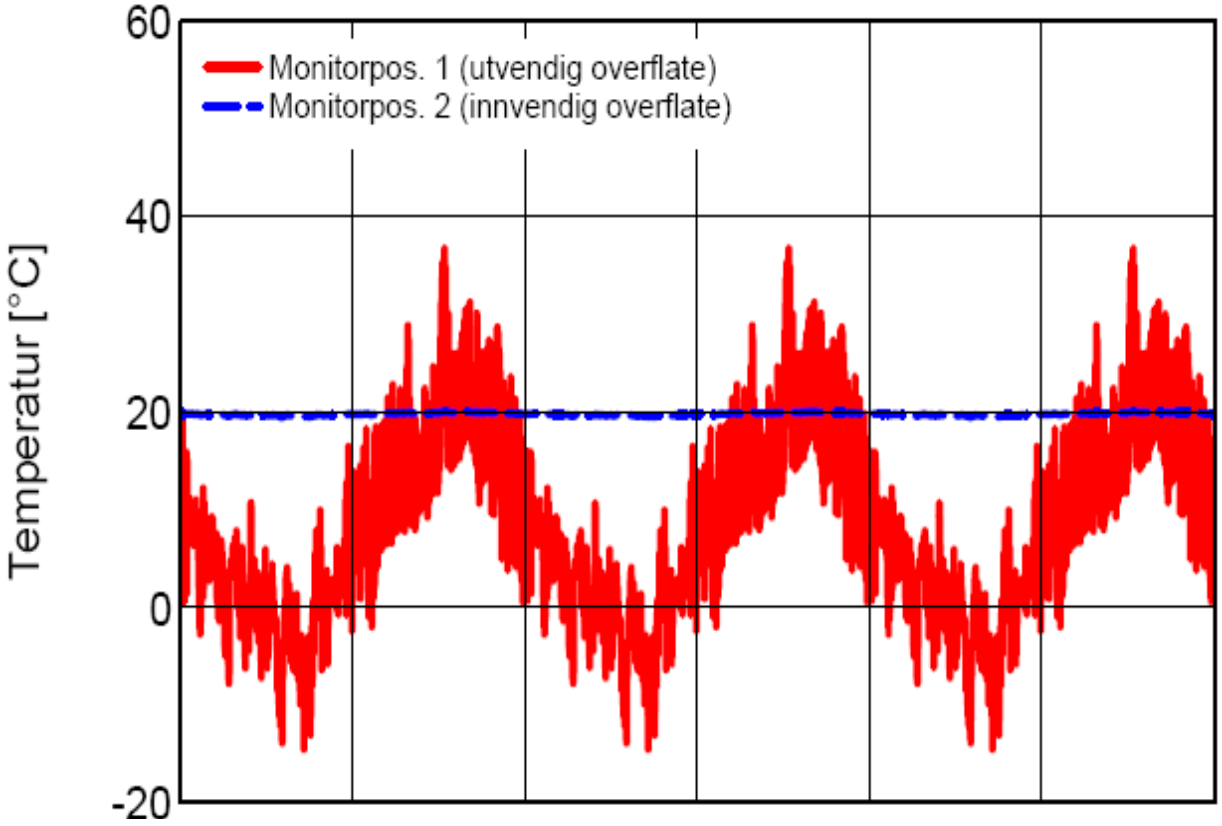


WUFI v4



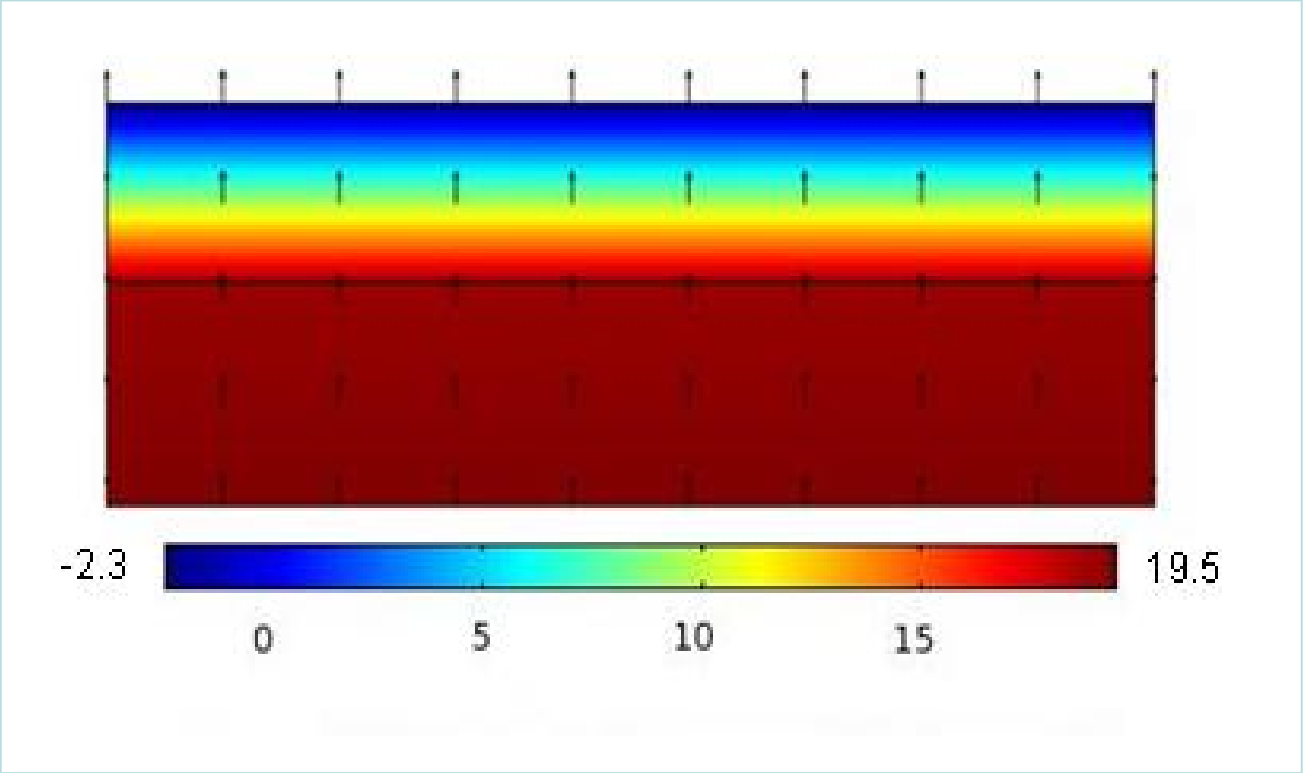
Low reflectance (black) roofing temperature plot (absorption coefficient α = 0.8)

WUFI v4



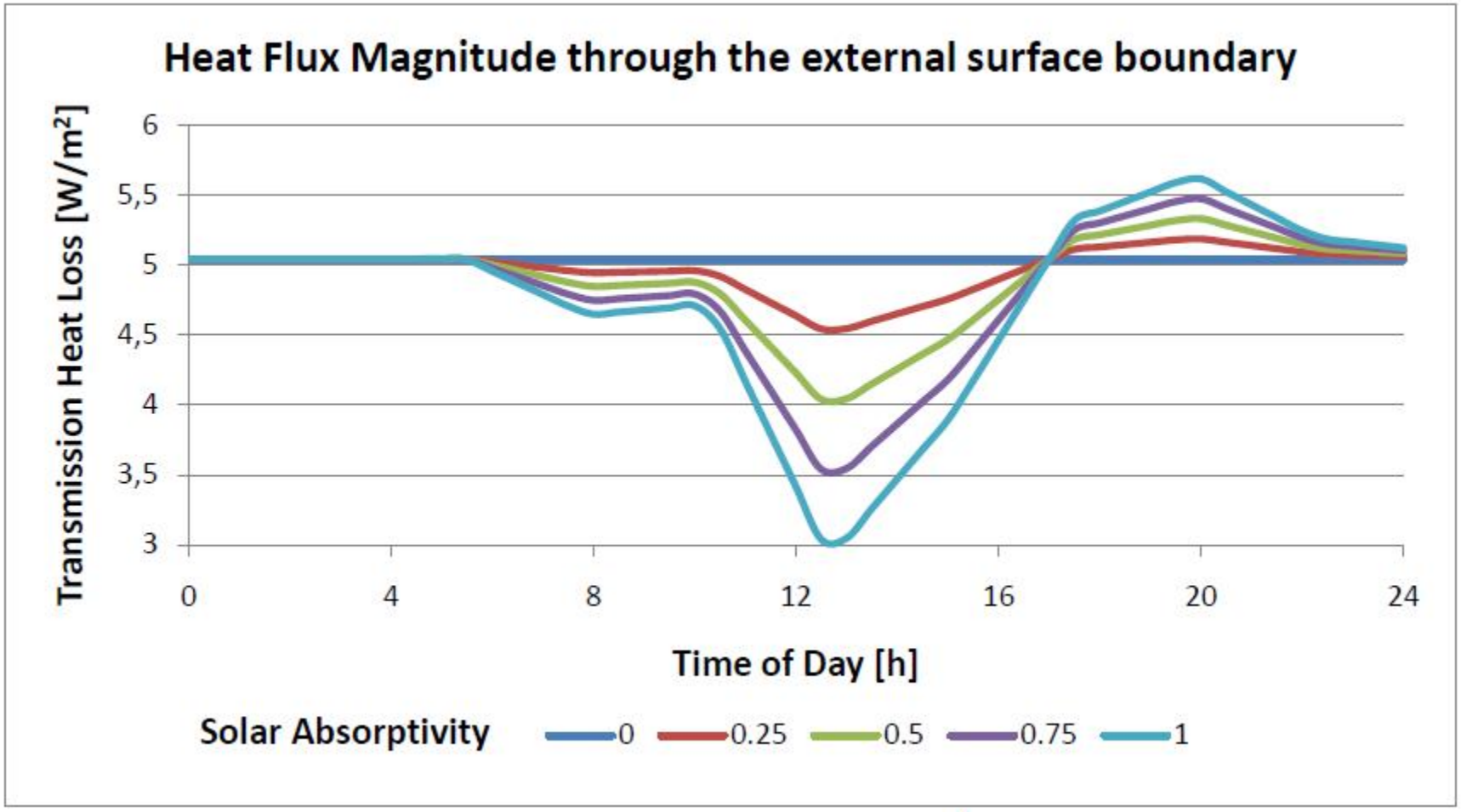
High reflectance (white) roofing temperature plot (absorption coefficient α = 0.2)

Comsol Multiphysics

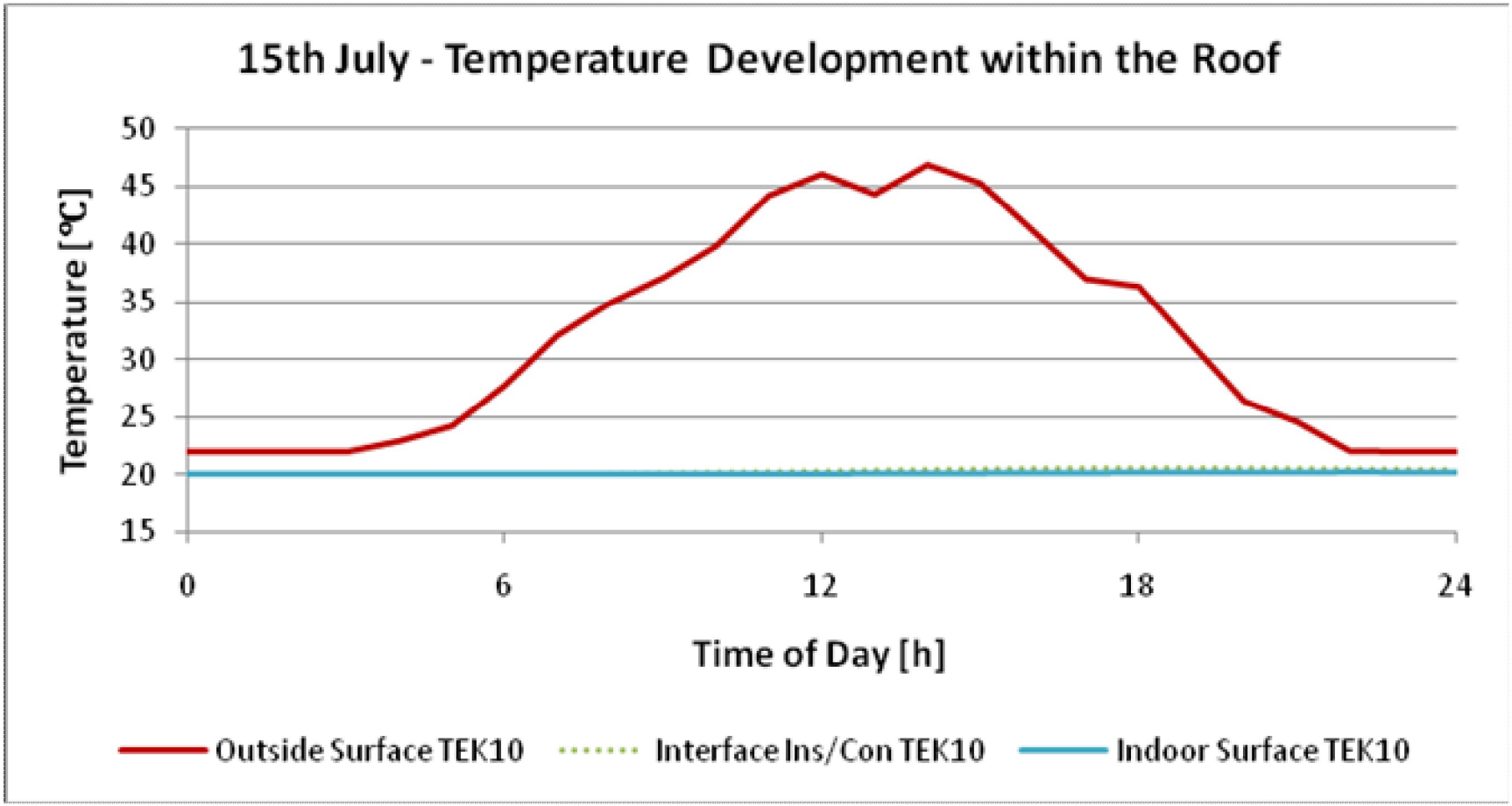


Steady state temperature distribution with -2.5°C outdoors and 20°C indoors.
The heat flux is represented by arrows.

15th March - Trondheim

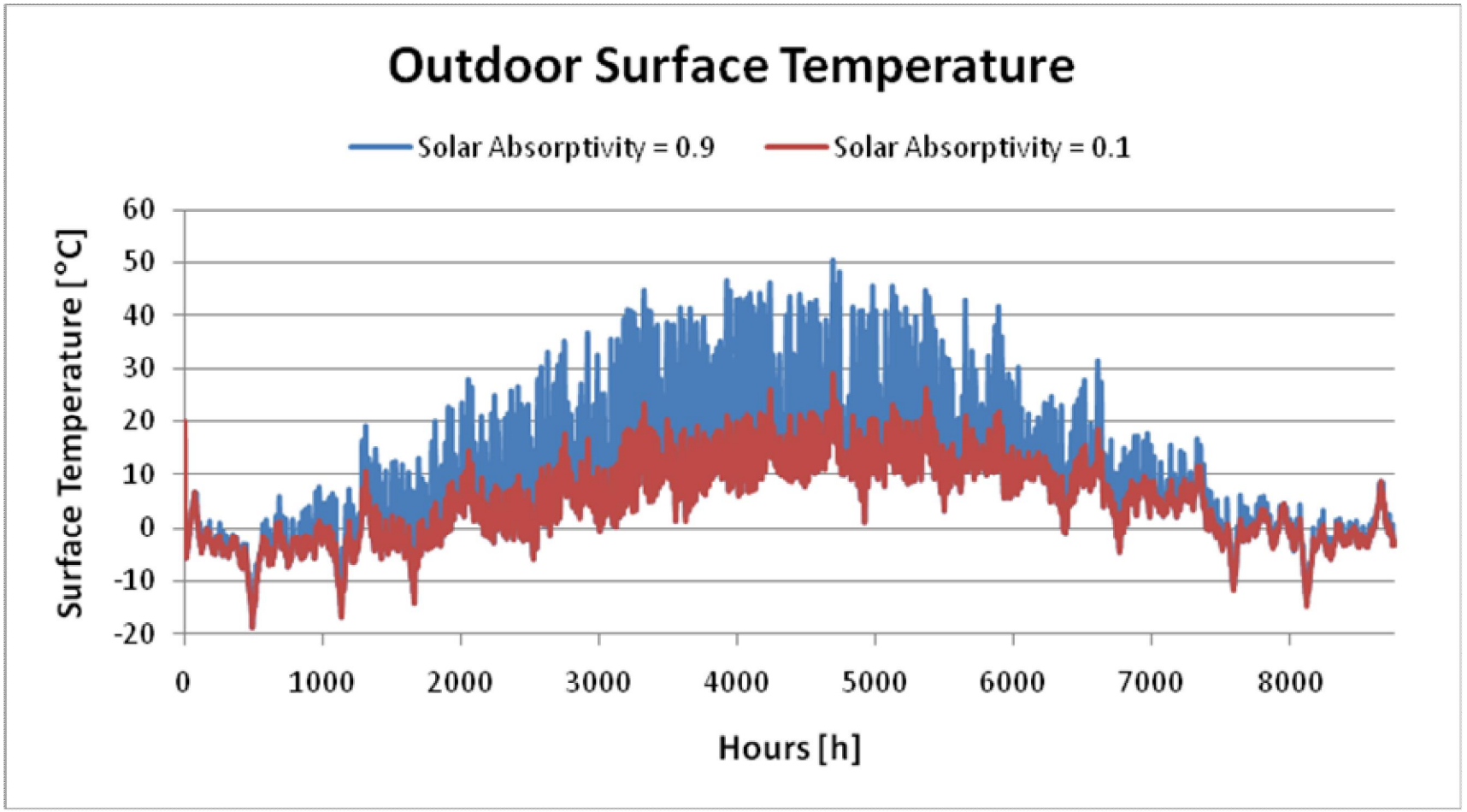


Summer Peak



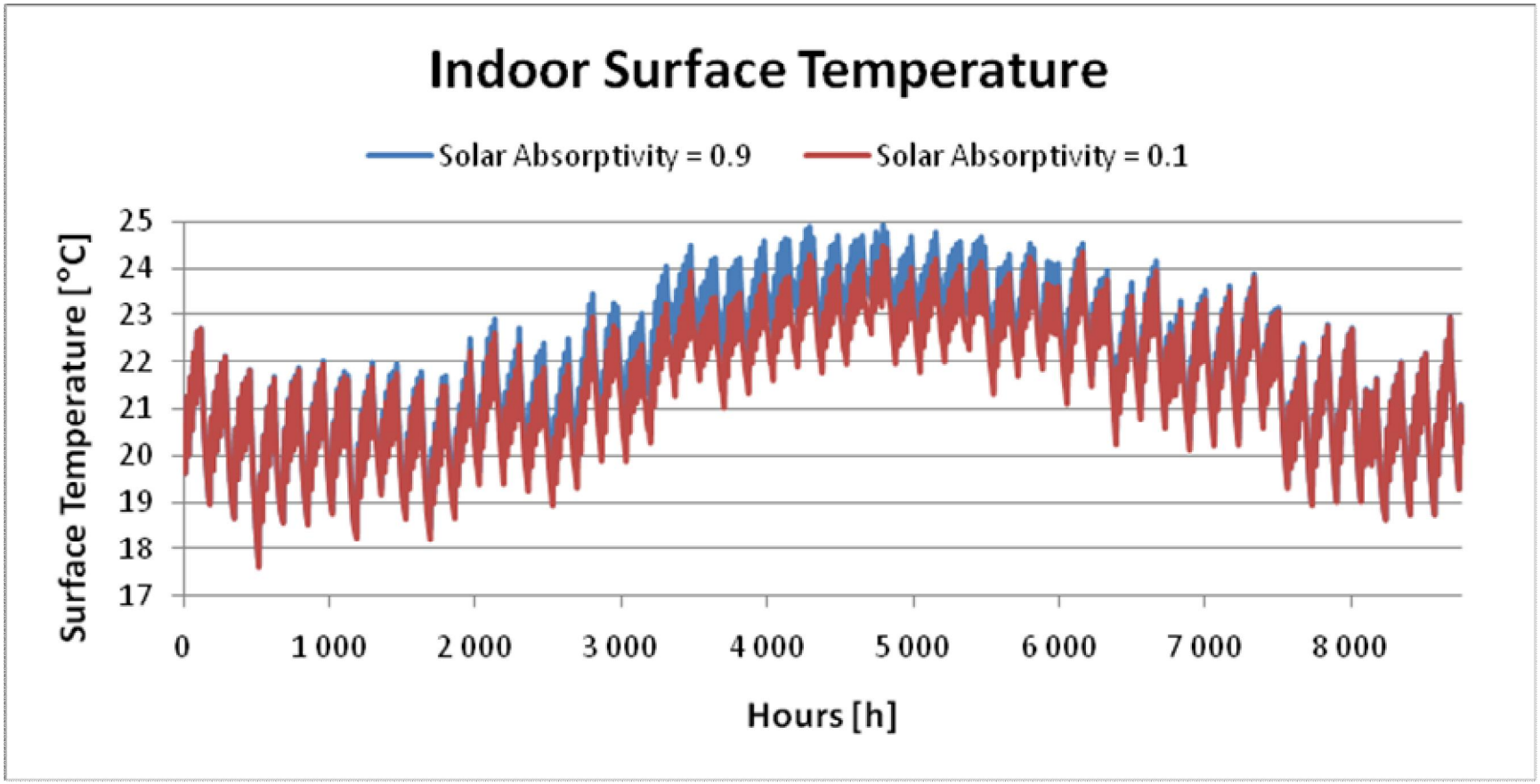
Temperature development of the indoor surface, interface between the concrete and insulation, and outdoor surface during 24 hours using solar data extracted from TRNSYS for the 15th July in Trondheim

TRNSYS



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/m^2K respectively. The internal heat gains were simulated first with 30 W/m^2 and then with 40 W/m^2.
- 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 m^2, and the floor to ceiling height was 2.5 meters.
- Trondheim, Norway Weather Climate

Energy Savings Potential

	30 W/m² Trondheim			40 W/m² Trondheim		
Solar Abs.	Heating	Cooling	Total	Heating	Cooling	Total
0.9	14315	741	15056	8358	6175	14534
0.6	14685	409	15095	8560	5686	14245
0.3	15100	182	15282	8788	5174	13962
0.1	15399	96	15495	8957	4819	13776

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.

	40 W/m^2 Los Angeles		
Solar Abs.	Heating	Cooling	Total
0.9	805	20670	21475
0.6	1166	15405	16571
0.3	1641	11514	13155
0.1	2082	9060	11143

- Energy savings potential of 8.6 kWh/m^2 relative the black surface.

Conclusion

- In a Nordic climate, as the internal heat gains increase to 40 W/m^2, a cool roof has only a marginal energy savings potential.

Thanks for Listening

- Any Questions ???

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