Investigating bio-based insulation

Hygrothermal performance: from material properties to the building envelope

OSKAR RANEFJÄRD

Research space – Reference group

SVENSK HUS PRODUKTION

Hjältevadshus

BO KLOK
SKANSKA & IKEA

Moelven

OBOS

Derome

LINDBÄCKS

TRIVSELHUS

tmf

EKSJÖHUS

Götenehus

VIDA

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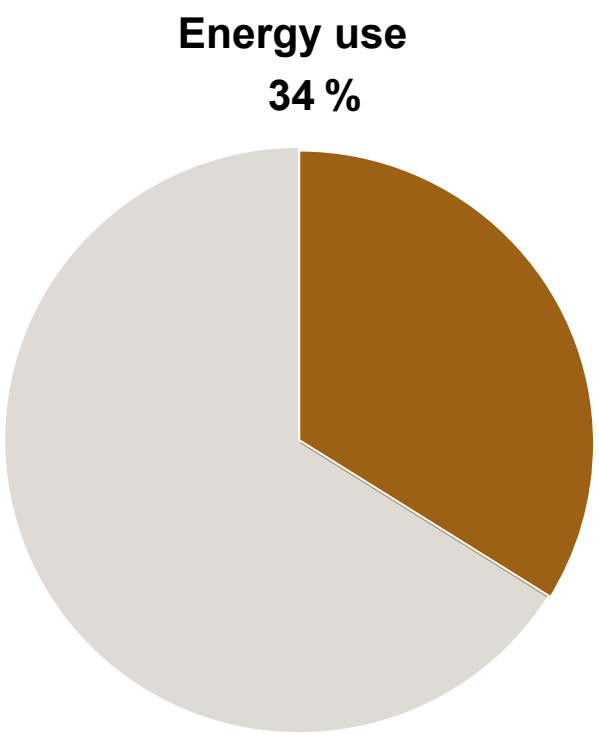
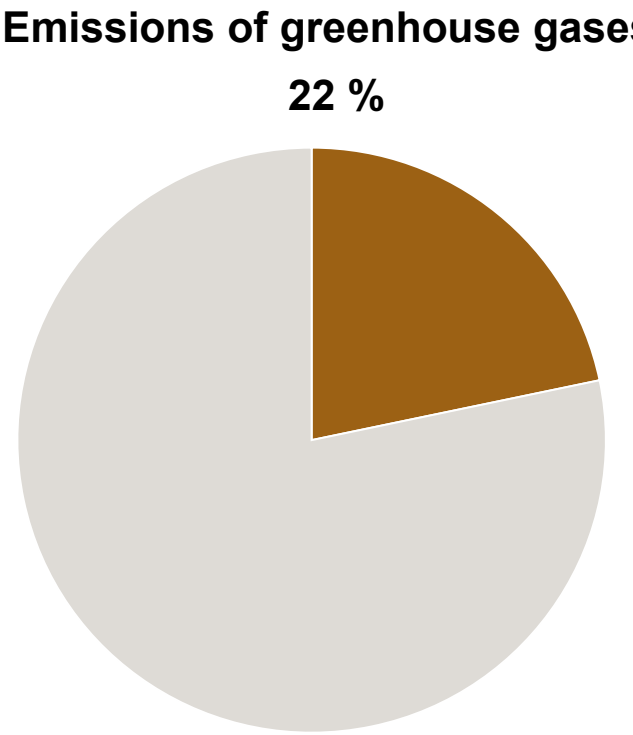
Research space - Construction sector's resource use





Source: Boverket miljöindikatorer

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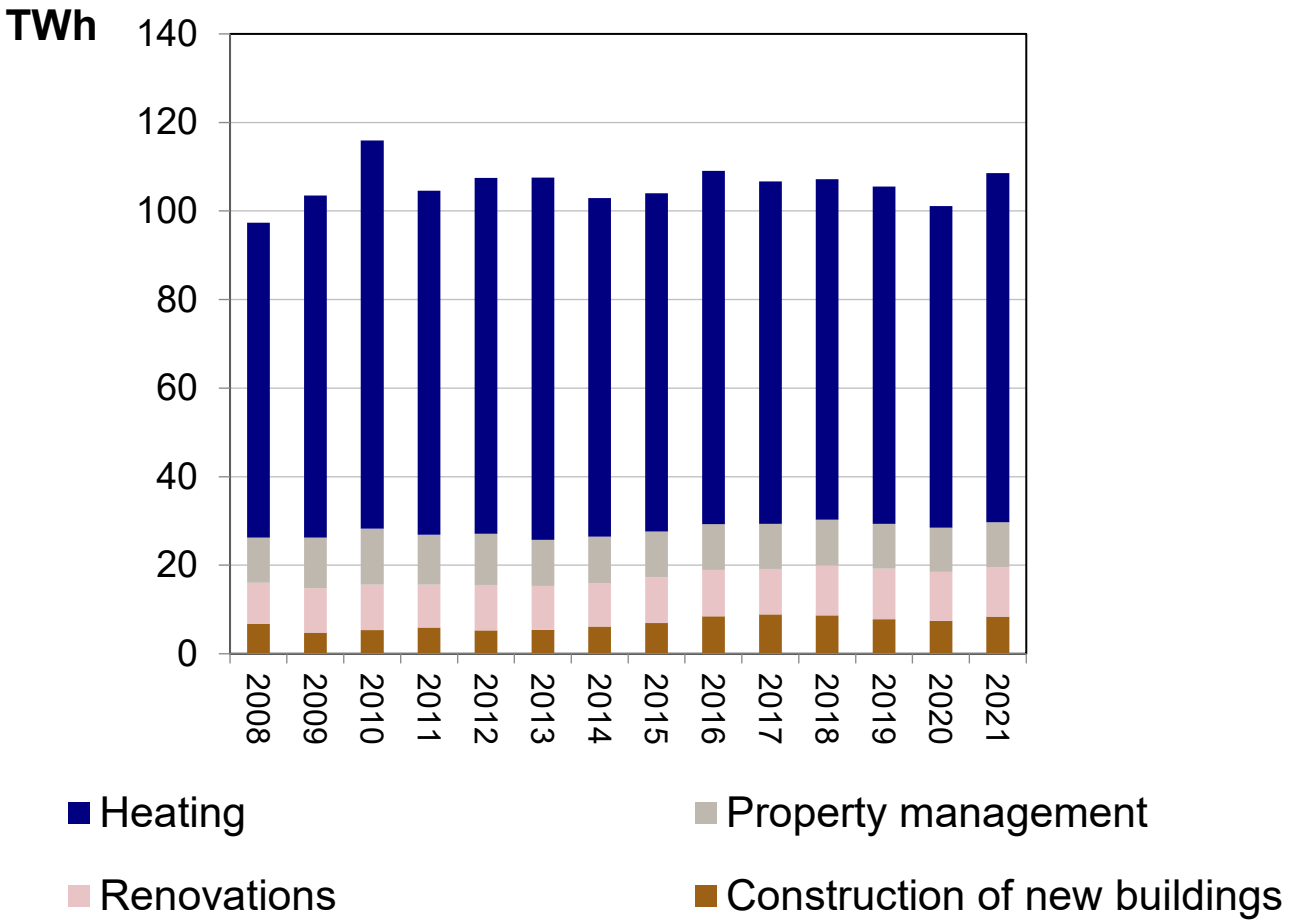
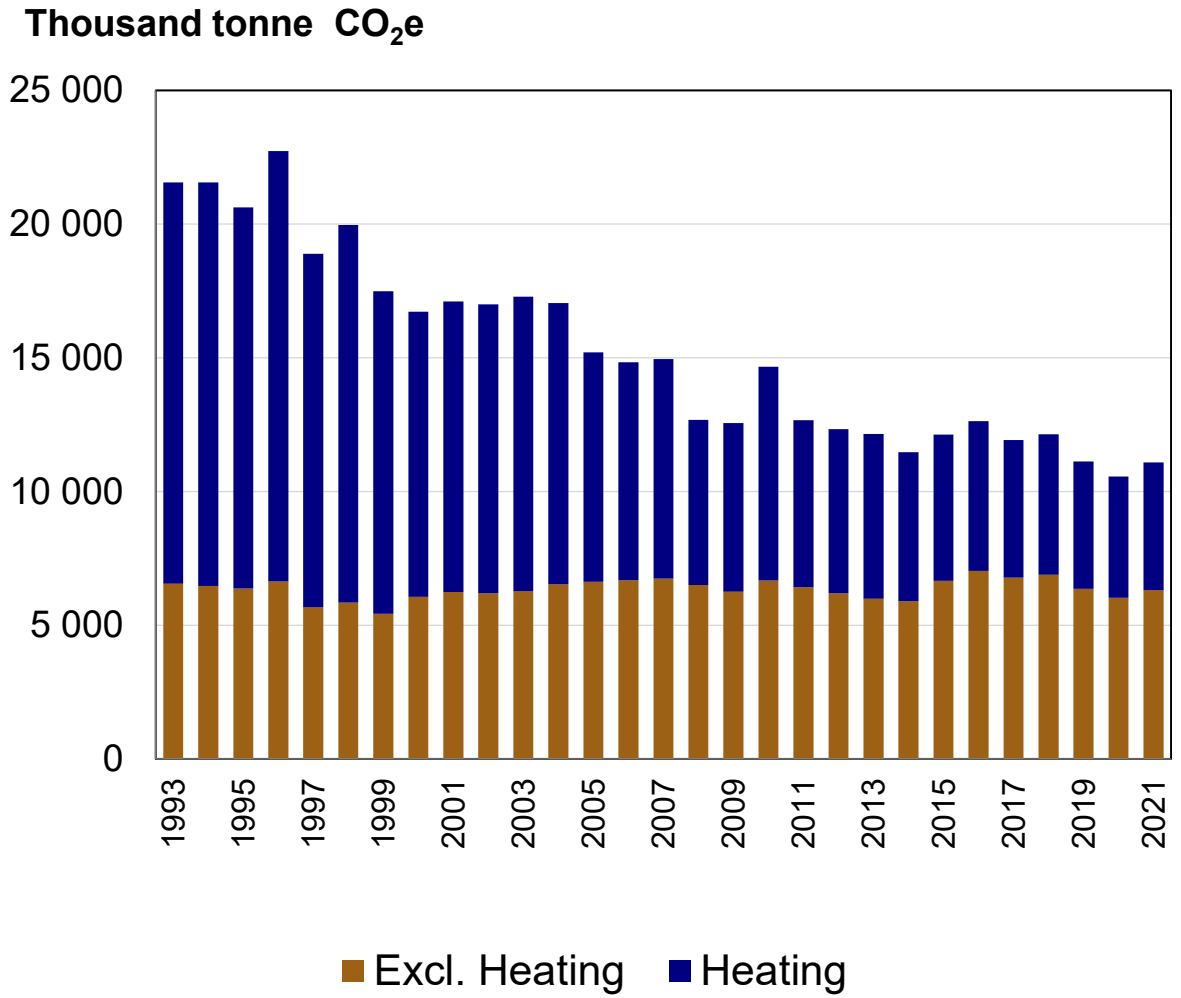
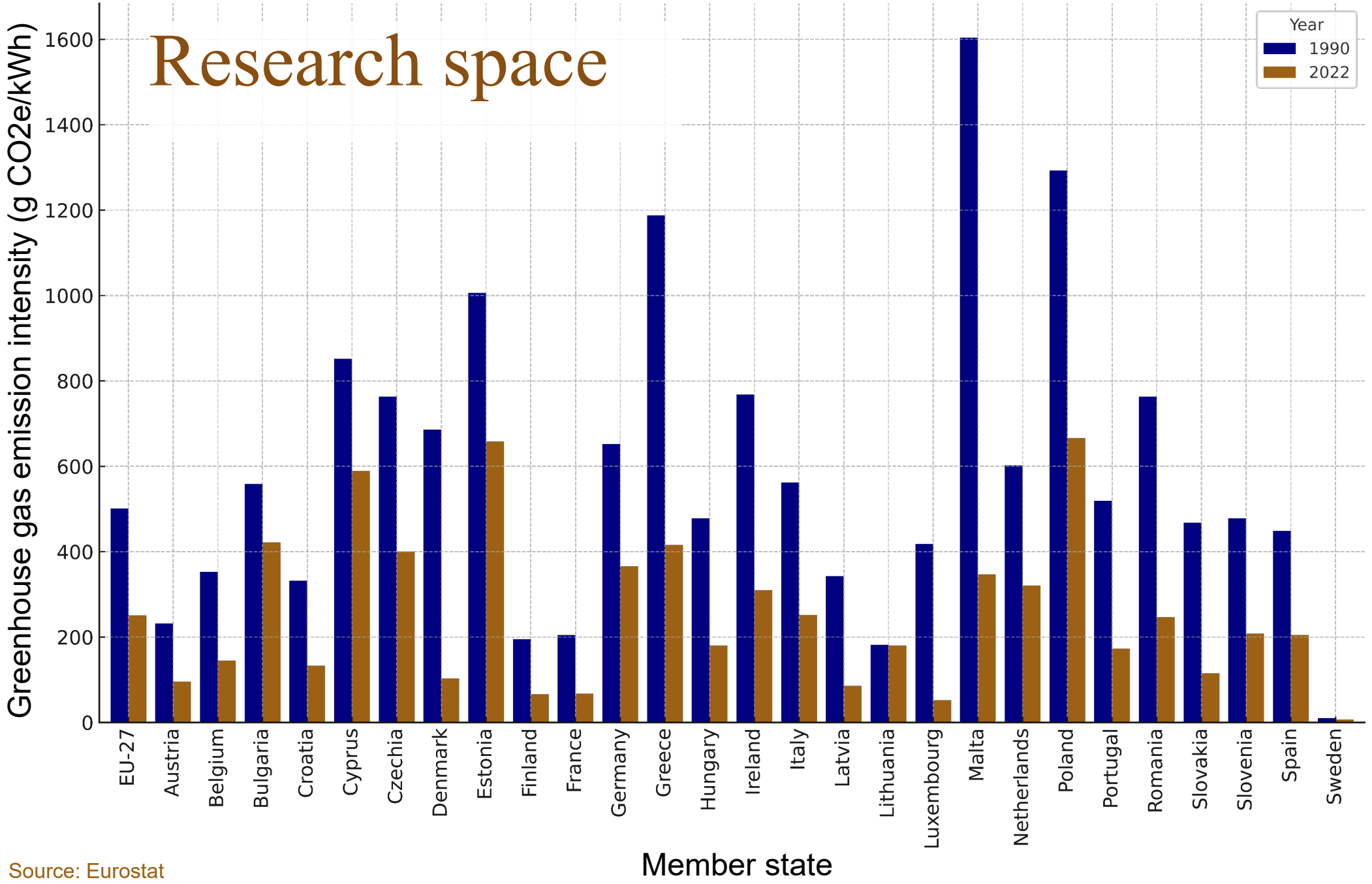
Research space - background





Source: Boverket miljöindikatorer

Research space



Source: Eurostat

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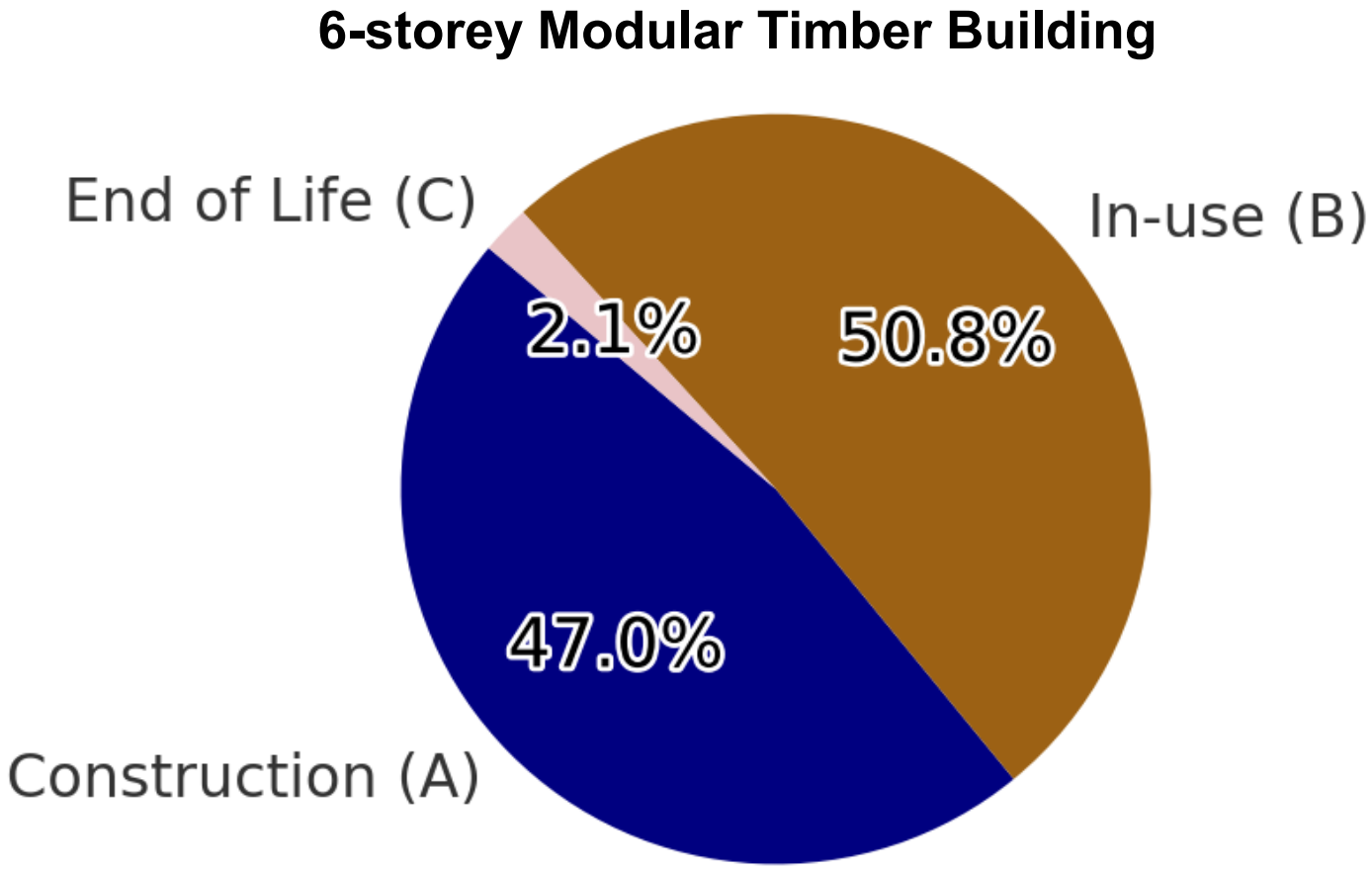
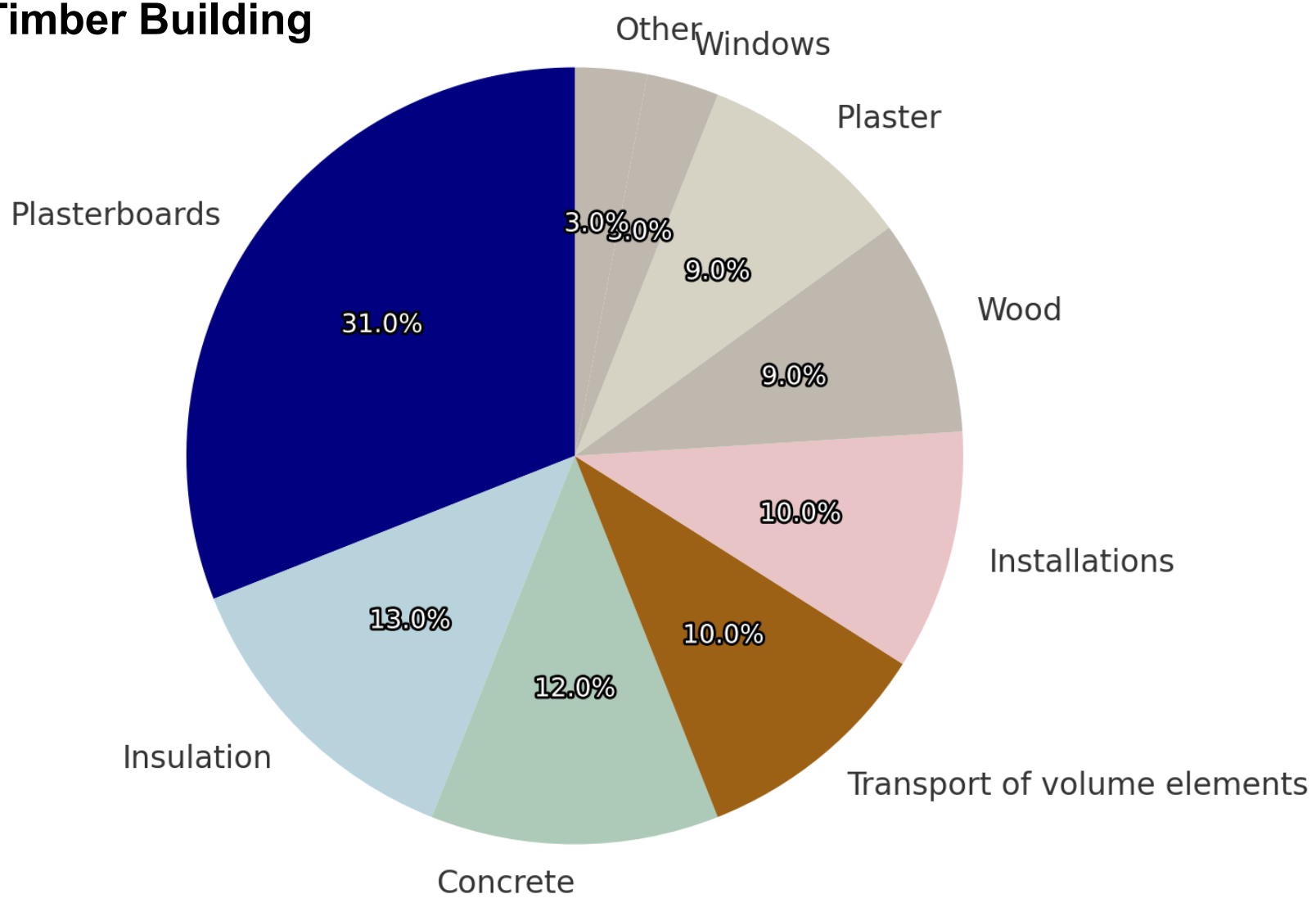
Research space – total emissions of a building



Source: IVL – Erlandsson et.al. 2018

Research space – total emissions of a building

6-storey Modular Timber Building



Source: IVL – Erlandsson et.al. 2018

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Bio-based insulation

- From natural and renewable materials such as plants or animals

Cellulose

Sheep wool

Cotton

Cork

Hemp

Straw

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Bio-based insulation – in this thesis

Wood fibre

Eelgrass

Grass

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Bio-based insulation

- Hygrothermal performance?

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Bio-based insulation

- Hygrothermal performance?

Portvakten, Växjö

Expected 55 kWh/m² per year
Measured 30 kWh/m² per year

Strandparken, Sundbyberg

Expected 75 kWh/m² per year
Measured 49 kWh/m² per year

Villa Funäsdalen, Härjedalen

Expected 46 kWh/m² per year
Measured 27 kWh/m² per year

Bio-based insulation

- Hygrothermal performance?

Portvakten, Växjö

Expected 55 kWh/m² per year
Measured 30 kWh/m² per year

Explanation: Wrong area

Strandparken, Sundbyberg

Expected 75 kWh/m² per year
Measured 49 kWh/m² per year

Explanation: Towel driers

Villa Funäsdalen, Härjedalen

Expected 46 kWh/m² per year
Measured 27 kWh/m² per year

Explanation: ?

Bio-based insulation

- Hygrothermal performance?
  - Latent heat?

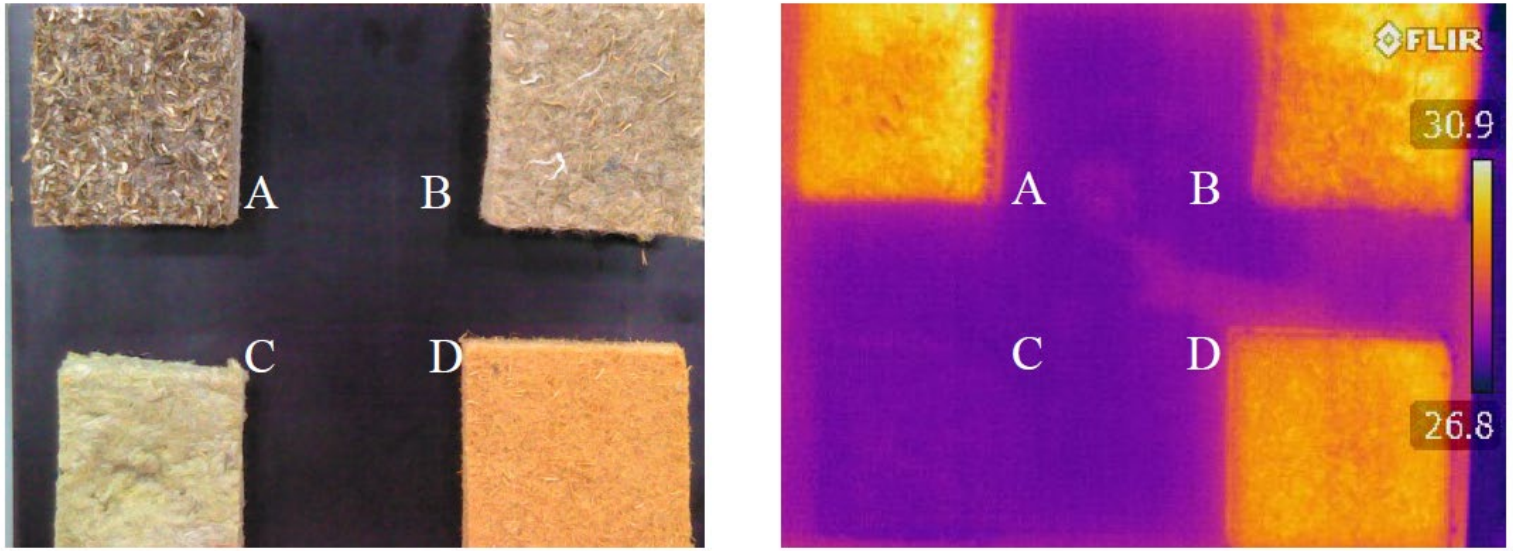

Figure 15: A simple experiment highlighting latent heat 90 minutes after increased relative humidity. On the left is a photograph, and on the right is a thermography image. Materials in the experiment are Eelgrass (A), Grass (B), Stone Wool (C), and Wood Fibre (D).

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Bio-based insulation

- Hygrothermal performance?
  - Latent heat?

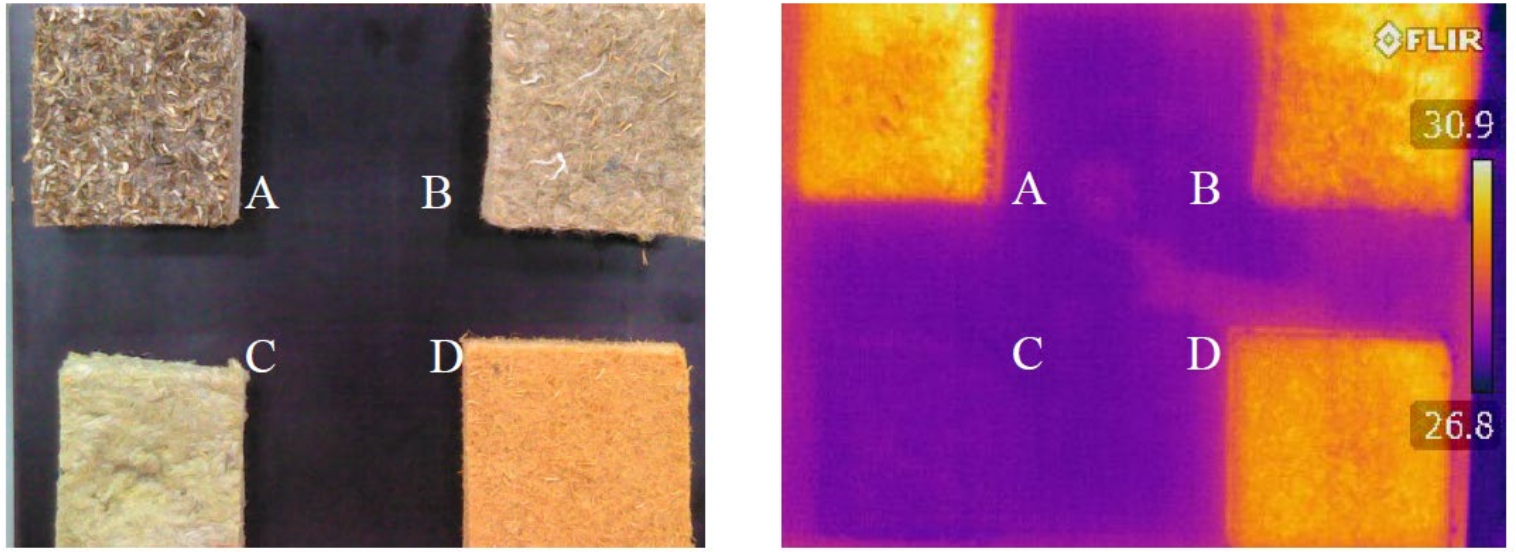
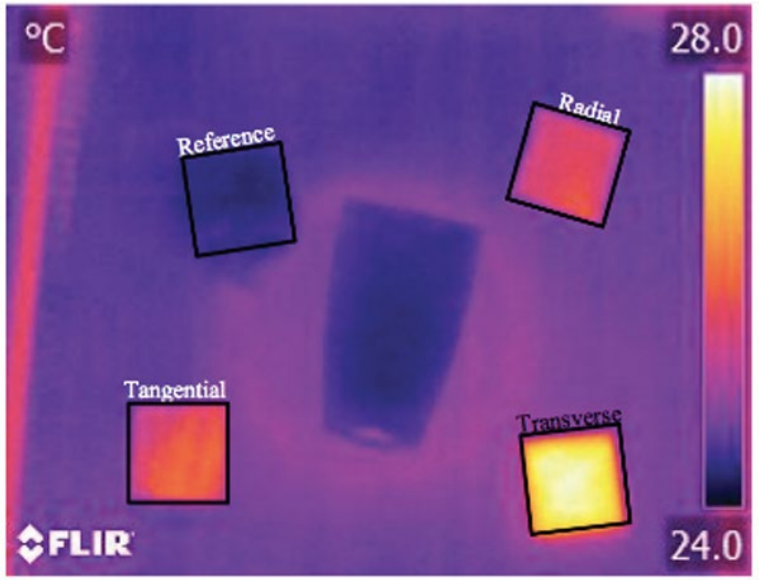


Figure 15: A simple experiment highlighting latent heat 90 minutes after increased relative humidity. On the left is a photograph, and on the right is a thermography image. Materials in the experiment are Eelgrass (A), Grass (B), Stone Wool (C), and Wood Fibre (D).

From Wood2New final report



Pseudo colour image of the surface temperature on wood surfaces measured using thermal imaging

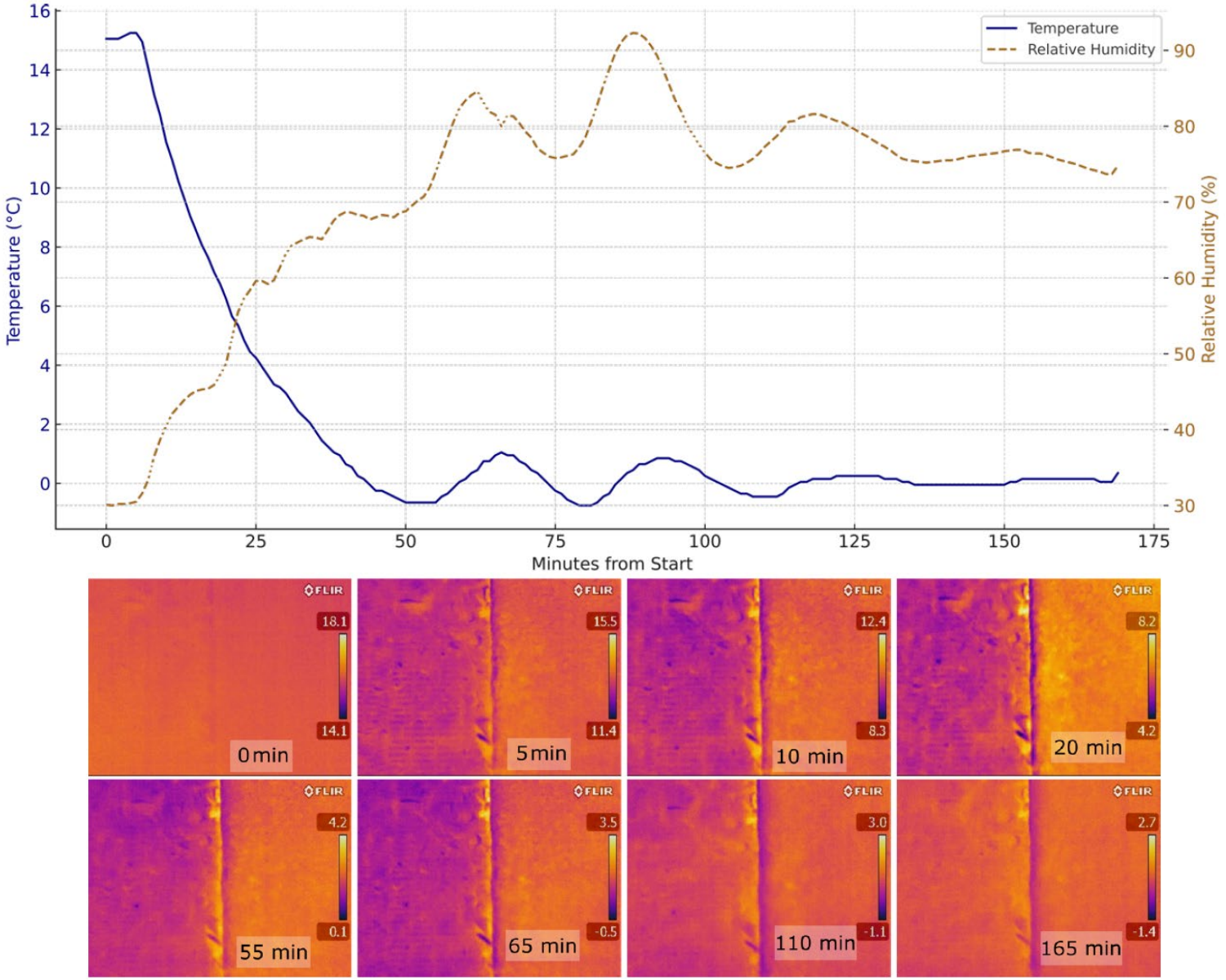


Figure 39: A simple experiment with a thermal camera and a climate room shows a mineral wool (left) and wood fibre (right) specimen conditioned at 15°C and 30% relative humidity being subjected to a sudden drop in temperature. The climate room was set to 0°C and 90% relative humidity (practically, it cannot control humidity below 10°C). Values on the pictures indicate when the thermography is taken.

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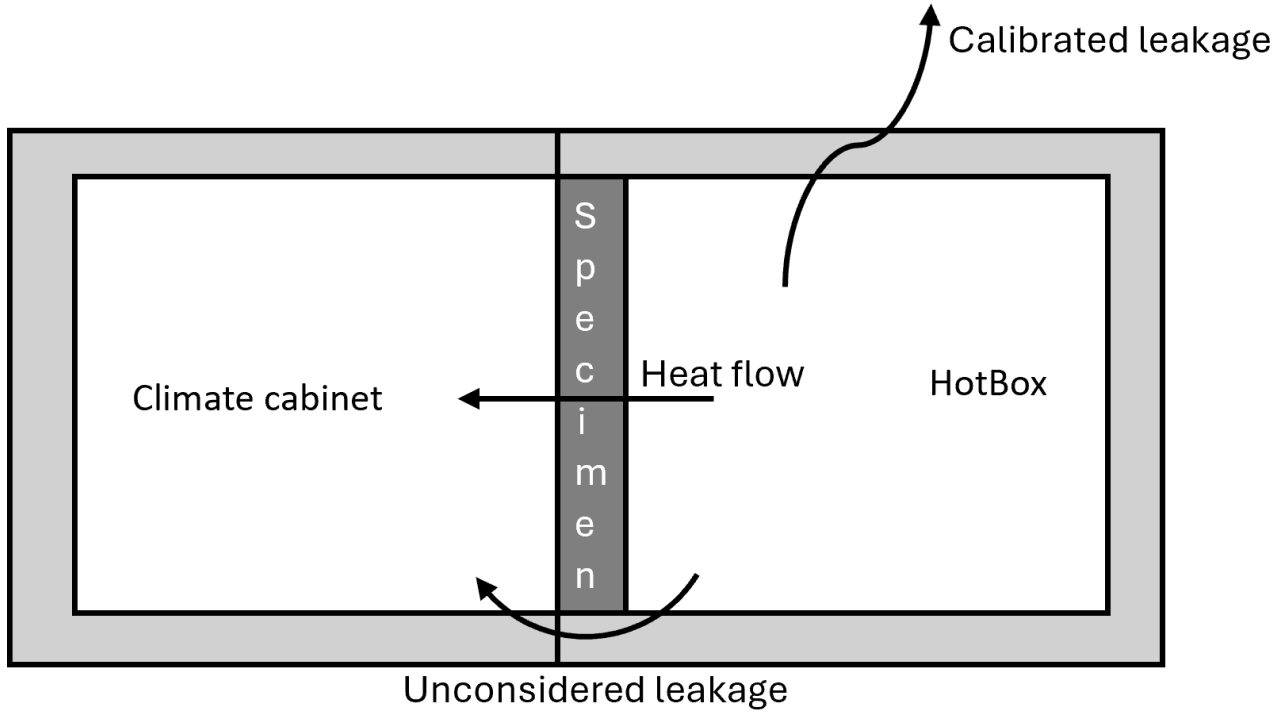
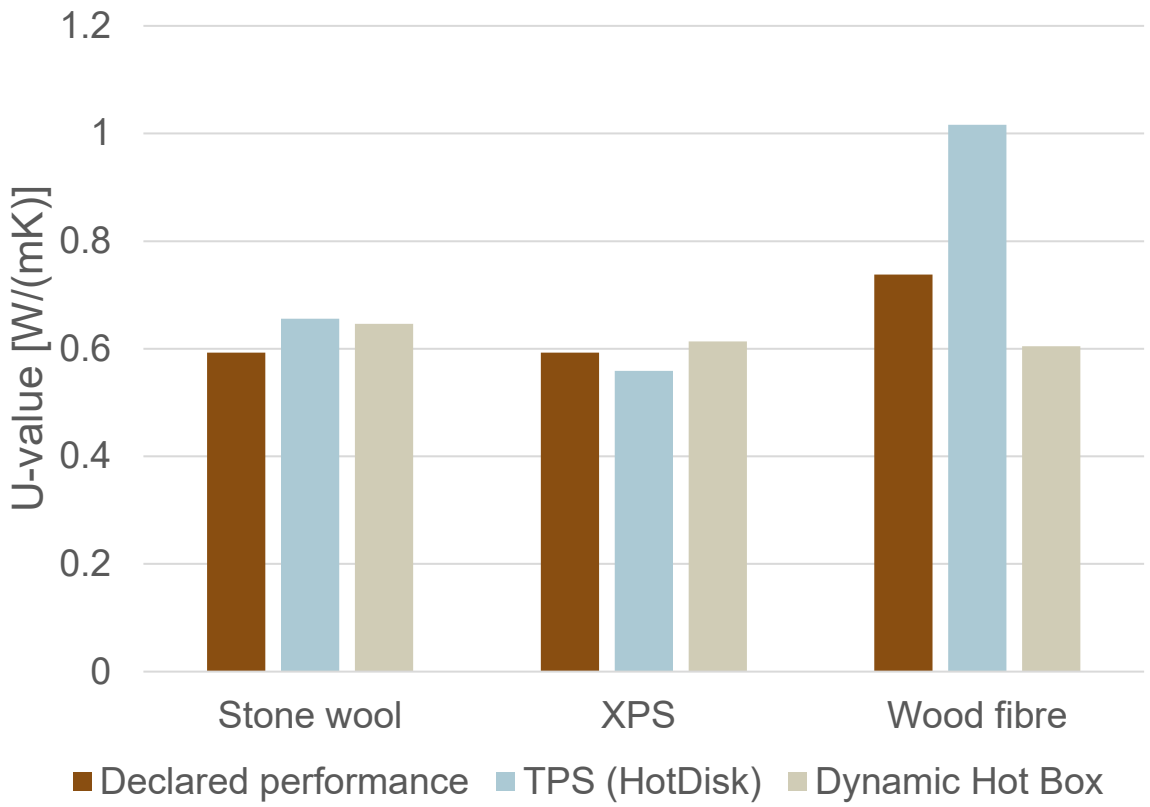
Paper I

Development of a Dynamic Hot Box Test Setup with Variable Outdoor Climate

Oskar Ranefjärd, PhD(s) **Eva F. Hansson, ASSOC PROFESSOR**
Anders Rosenkilde, ADJ PROFESSOR

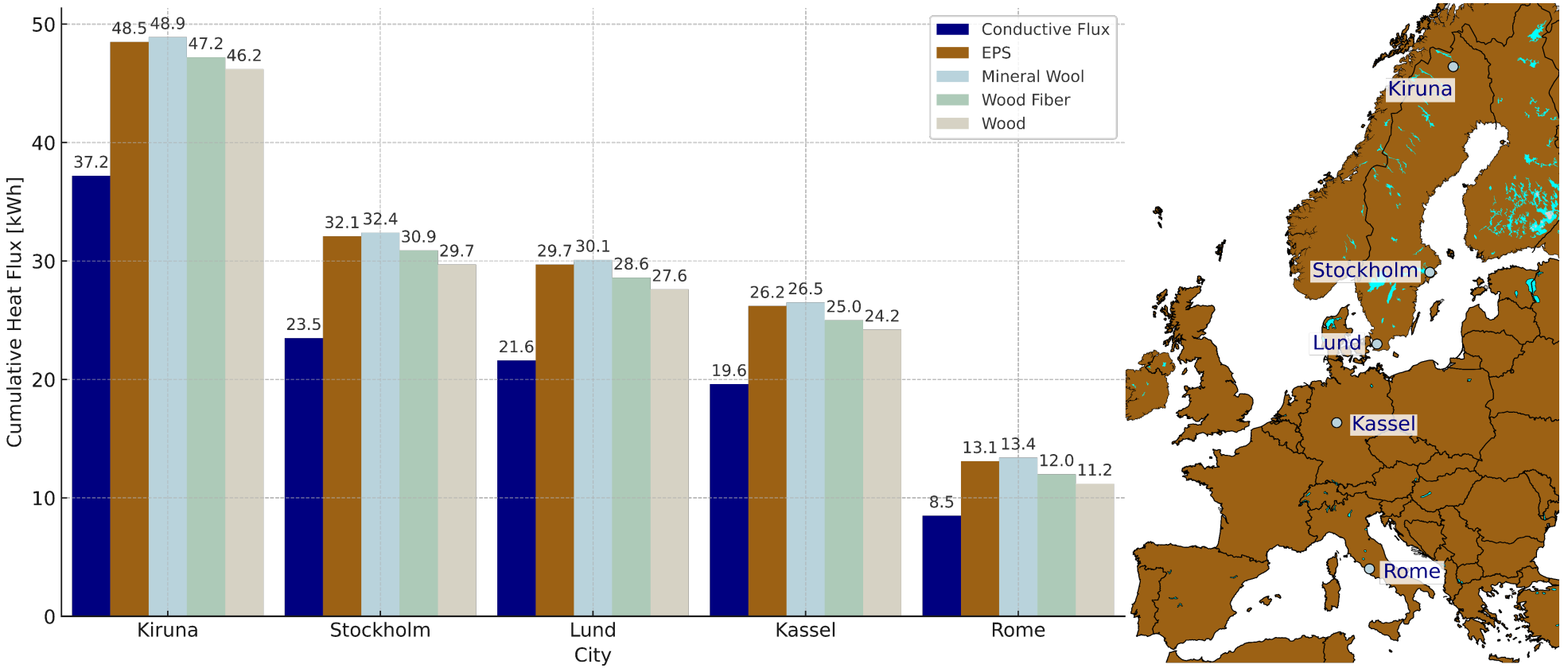




Paper II

Investigating the Potential of Latent Heat in Hygroscopic Insulating Materials

Oskar Ranefjärd
Anders Rosenkilde, PhD
Jonas Niklewski, PhD
Eva Frühwald Hansson, PhD
Paulien Strandberg-de Bruijn, PhD



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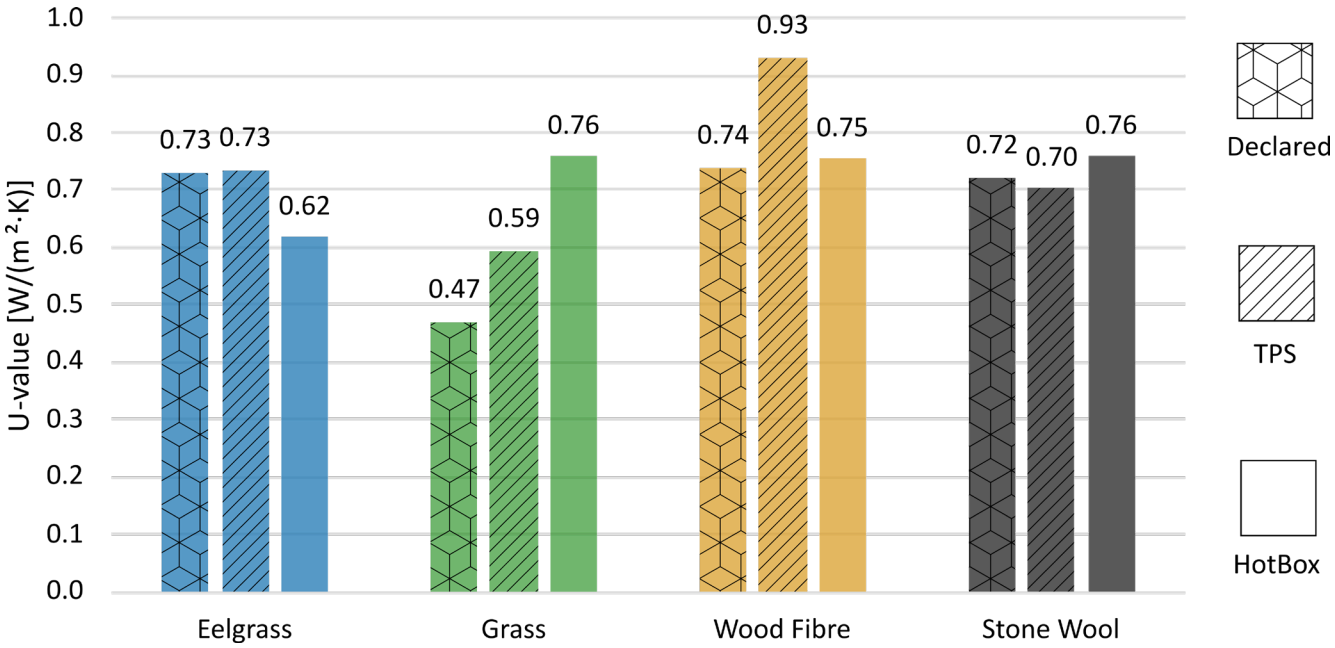
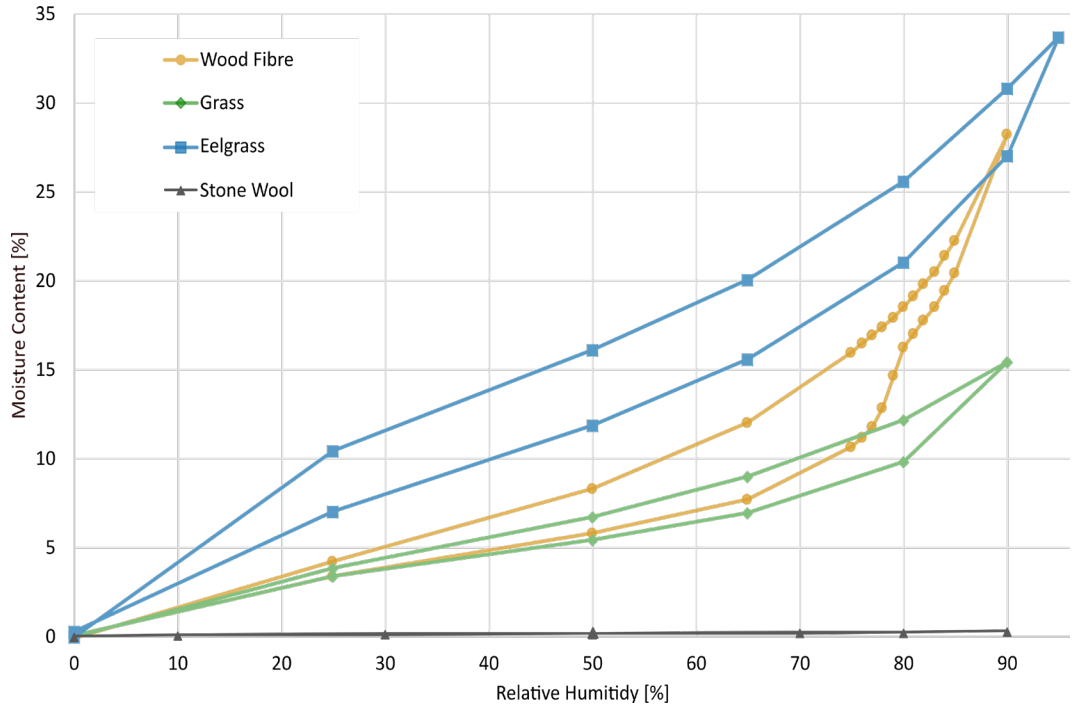
Paper III

Article

Hygrothermal Properties and Performance of Bio-Based Insulation Materials Locally Sourced in Sweden

Oskar Ranefjärd *, Paulien B. Strandberg-de Bruijn and Lars Wadsö



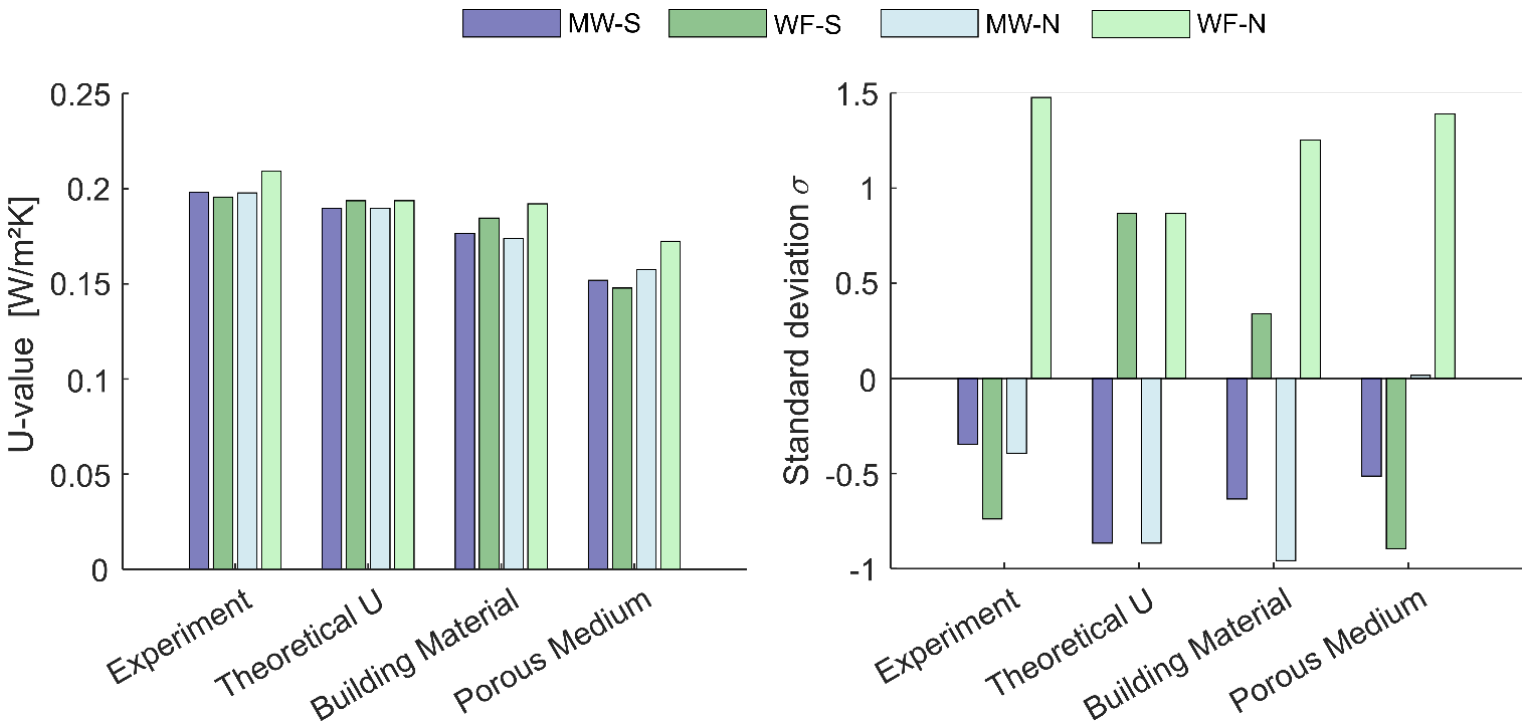


Sorption isotherms
Thermal conductivity
Thermal diffusivity
U-value

Volumetric heat capacity
Mixing enthalpy
Moisture buffer value

Assessing the Energy Performance of Wood Fibre and Mineral Wool Insulation through a Co-Heating Test

Paper IV



Conclusions

- Thermal conductivity is not a good approximation of the U-value for hygroscopic insulation materials
- Latent heat and thermal lag influence the heat flux through a wall
- Bio-based material's sorption properties are very different compared to conventional insulation materials
- Is it possible to build walls using bio-based insulation, fulfilling Swedish codes

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