RIGA TECHNICAL UNIVERSITY

Optimisation of energy efficiency measures in historic buildings

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RIBuild

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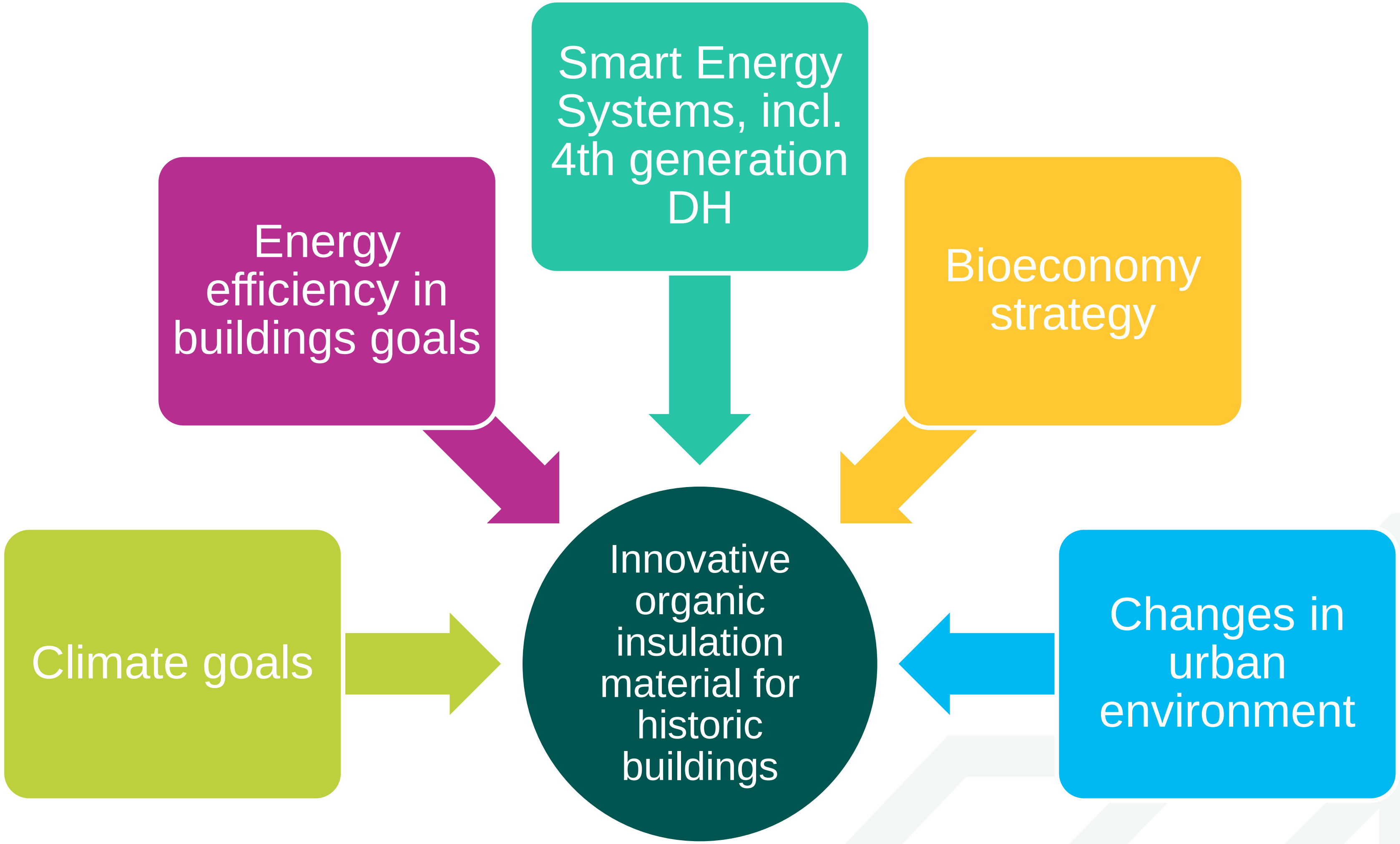
RiBuild: Robust internal insulation for historic buildings

www.ribuild.eu

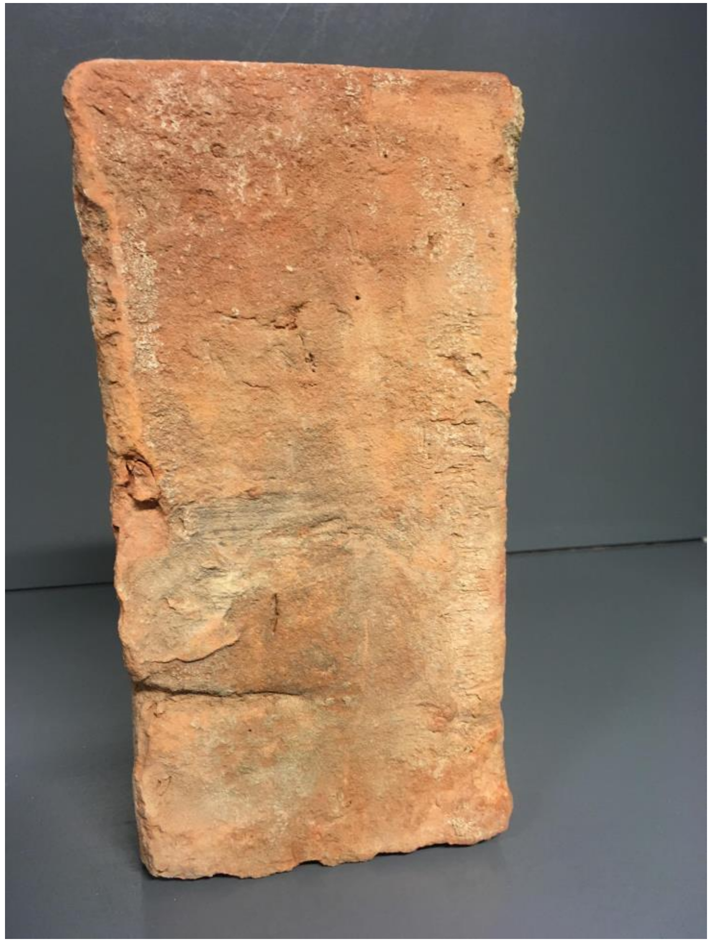
Interdisciplinary research



Challenges

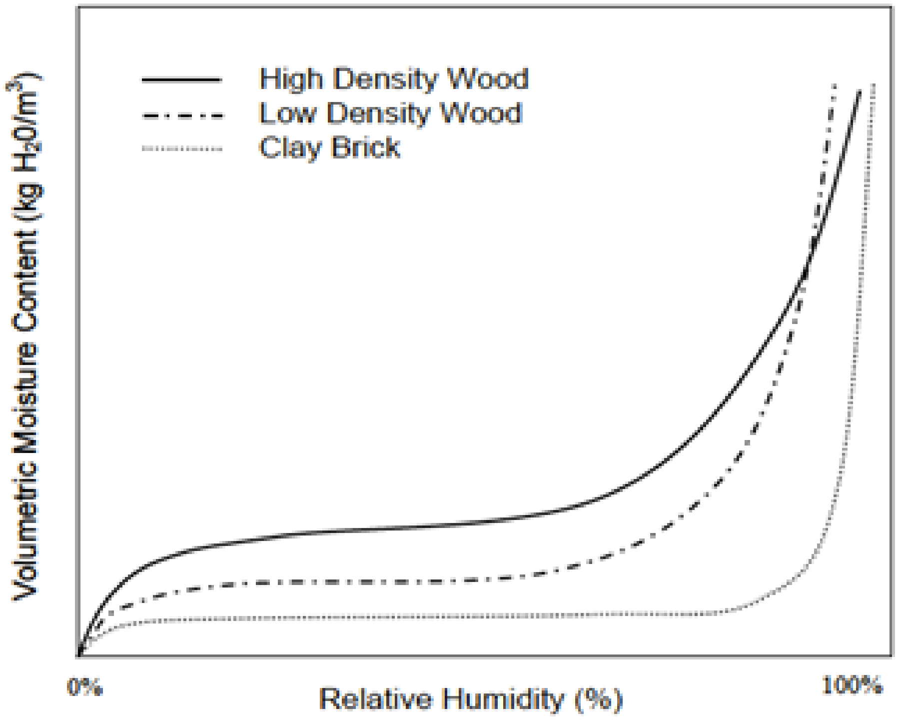
- Energy efficiency and heritage value are opposite goals
- Internal insulation is one of the most complicated EE measures

Porous materials



Moisture and porous materials

- Moisture transport
- Moisture accumulation
- Moisture sources:
  - Groundwater
  - Wind drive rain
  - Water losses from pipes
  - etc.



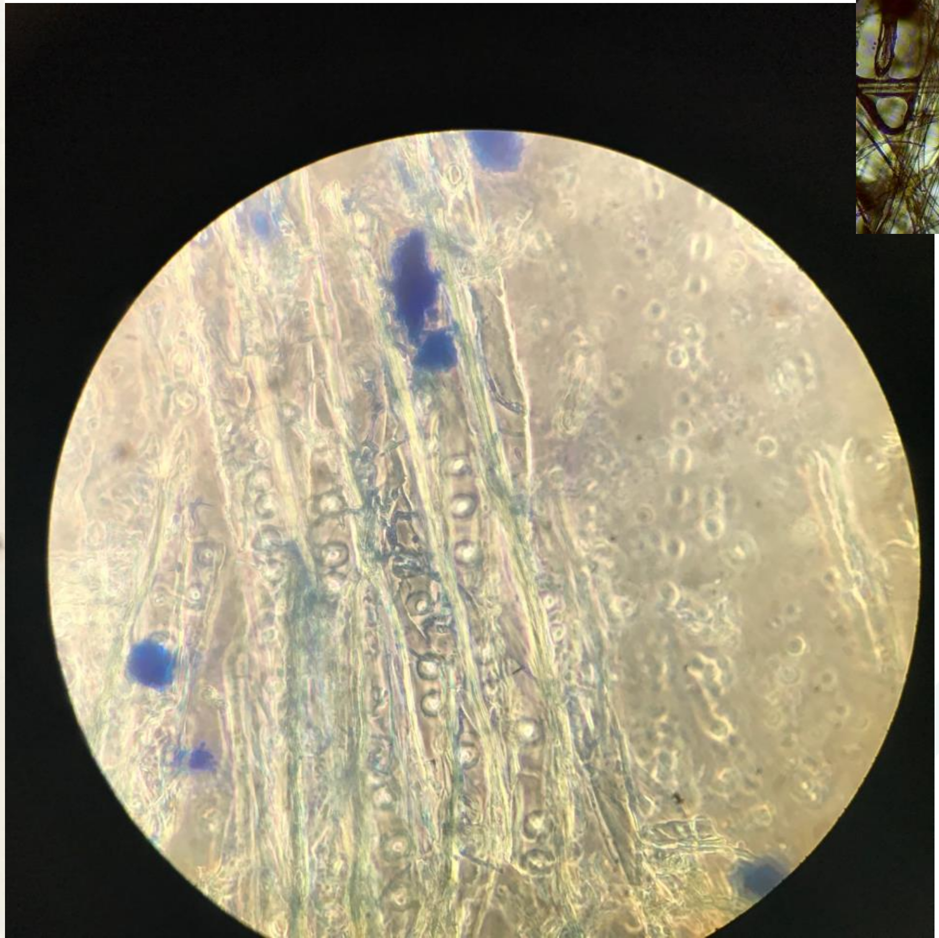
Moisture damages on external walls

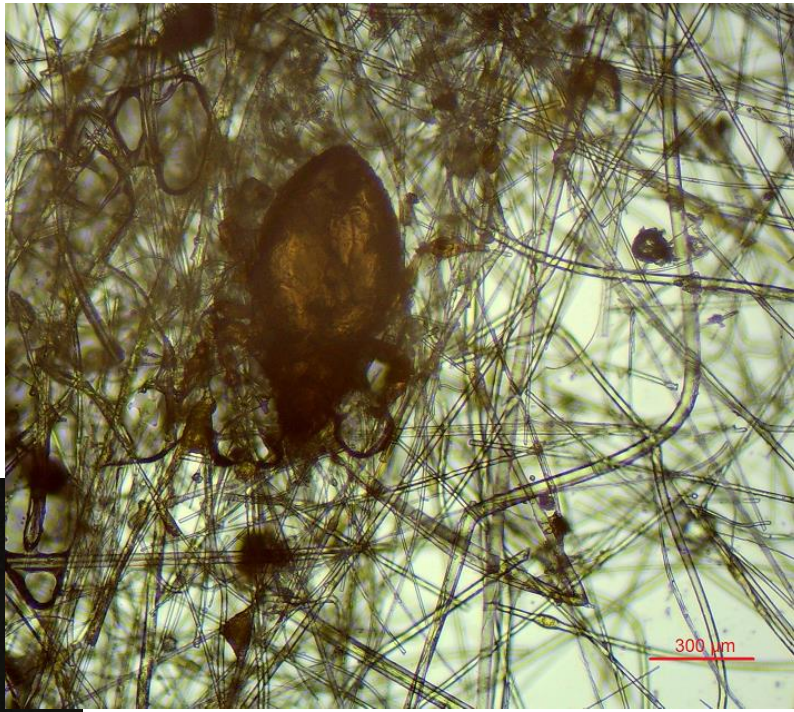




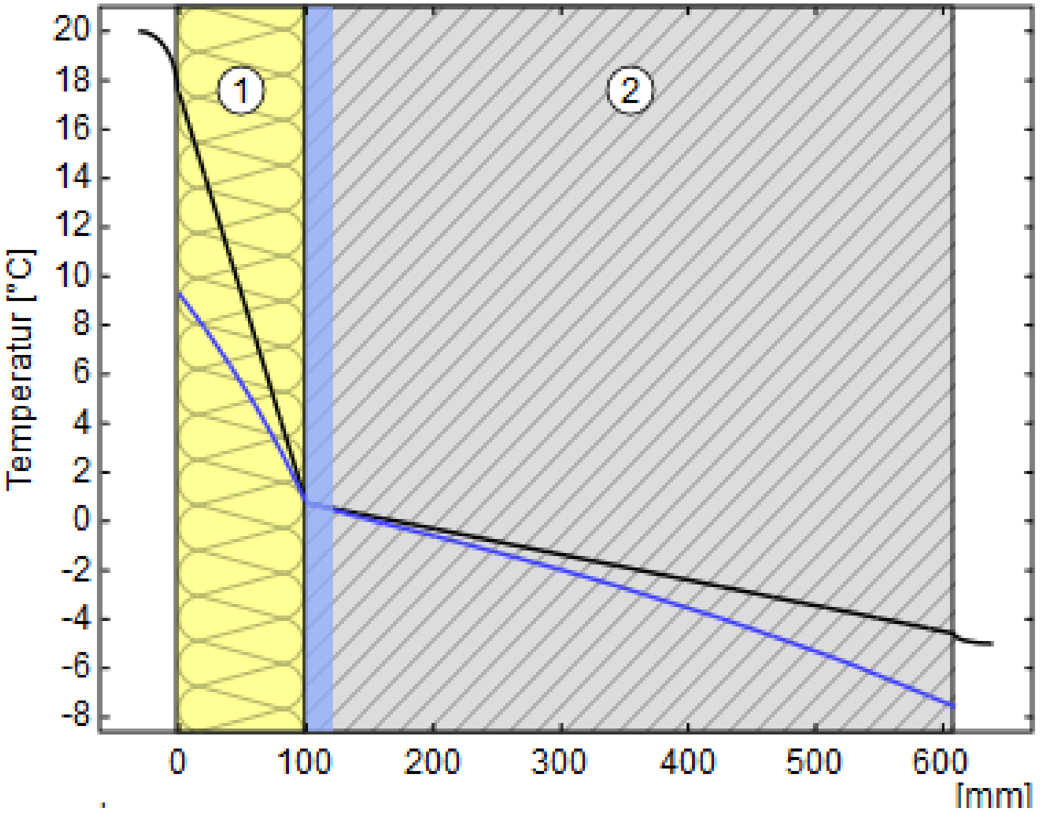


Moisture damages on external walls



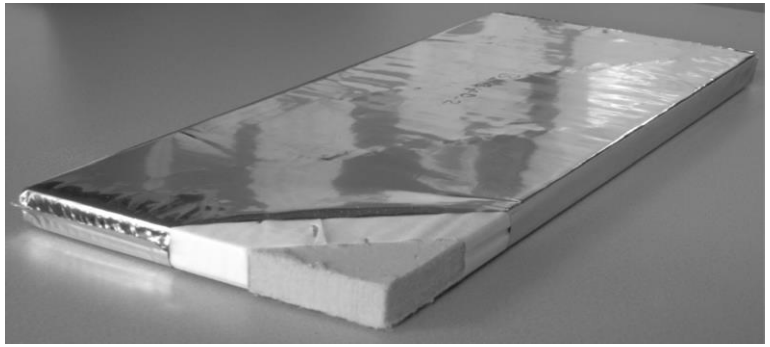


Internal insulation and condensation

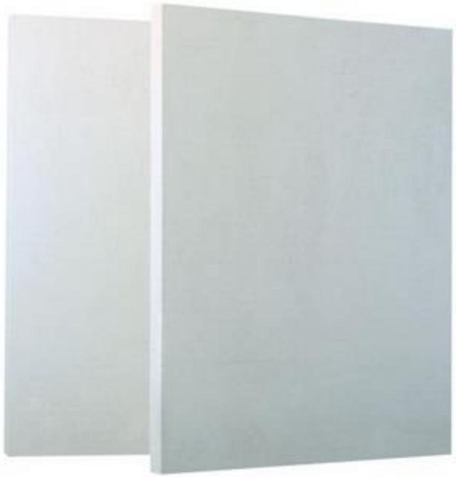


Which insulation?

Insulation materials for internal insulation



http://www.knaufinsulation.lv/produkti/ecose-mineralvate-gmw



http://www.ecologicalbuildingsystems.com/Ireland/Products/Product-Detail/Calstherm-Board

Vapour tight systems

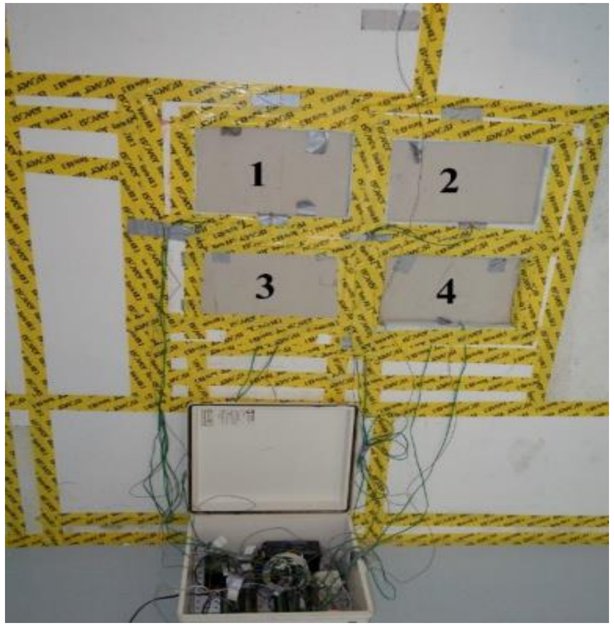
Capillary active insulation

Fossil based vs organic based materials

- Internal insulation can be carried out either with fossil or organic based insulation materials.
- **EU Bioeconomy Strategy** has set course for a resource-efficient and sustainable economy with the goal to reach more innovative and low-emissions economy by using renewable biological resources from land and sea to produce food, materials and energy.
- Application of **bioeconomy principles** to renovation of buildings is very actual.
- Although the life cycle of organic insulation materials is based on bioeconomy principles, currently they **are avoided** for internal insulation due to high moisture level which causes **mould growth risks**.

Previous research

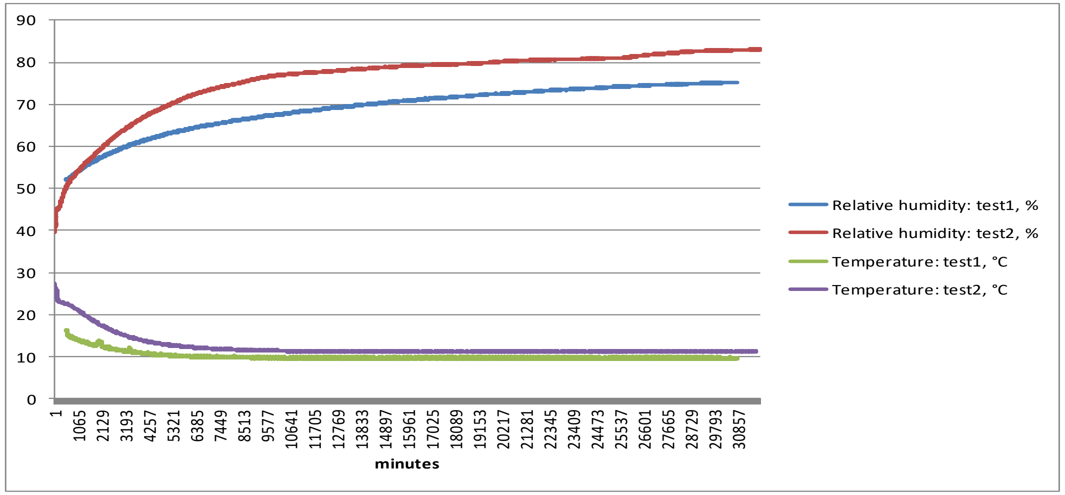
Laboratory tests of massive walls

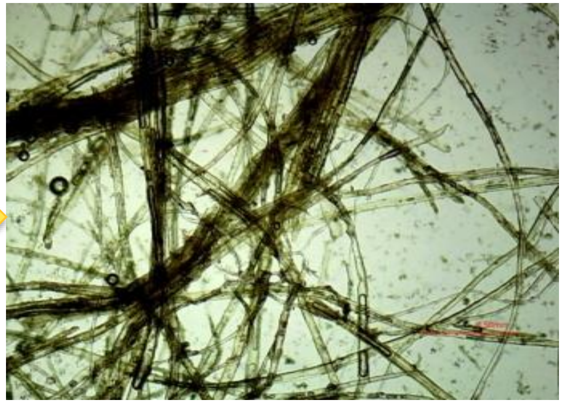


- Indoor:
  - Temperature +20ºC
  - RH 55%
- Outdoor:
  - Temperature 0ºC
  - RH 85%
- 22 days
- 2 test rounds

- Relative humidity:
  - **Mineral wool** with vapor barrier: 85,5%
  - **EPS**: 82%
  - **Wood fiber** without vapor barrier: 82%
  - **Aerogel** with vapor barrier: 81%
  - Wood fiber with vapor barrier: 76%
  - Aerogel with vapor barrier : 76%
- Temperature between brick wall and insulation materials: +10ºC.

Woodfiber insulation





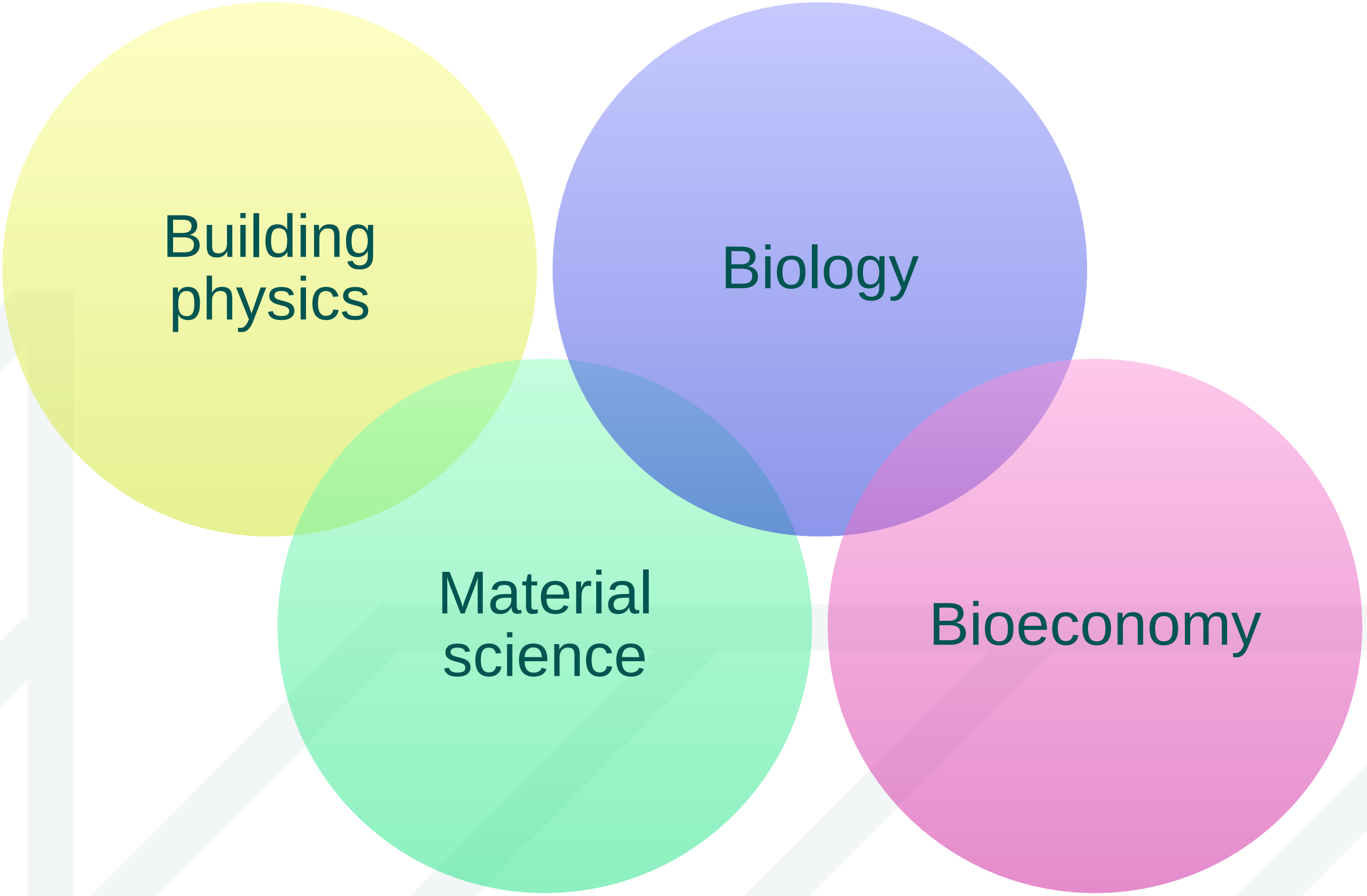
75%<RHcrit<80%

15

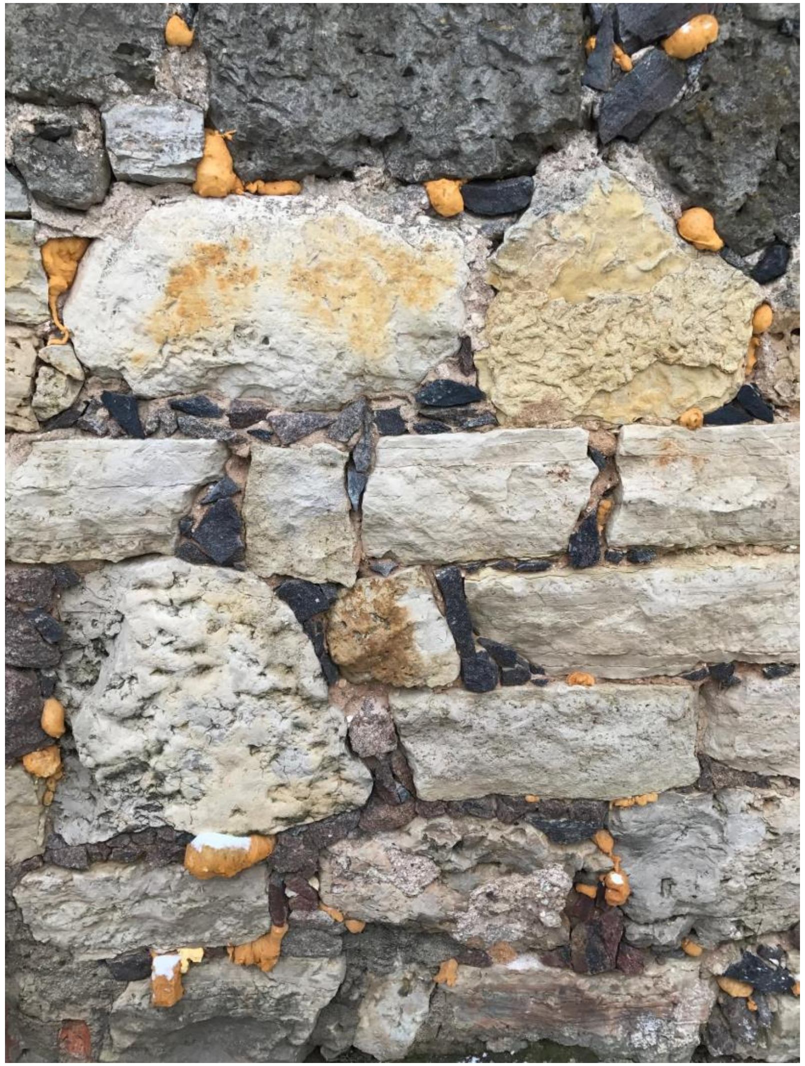
The goal of the study

- to find optimal solution for application of innovative organic insulation material made from pine needles for internal insulation of historic massive walls.

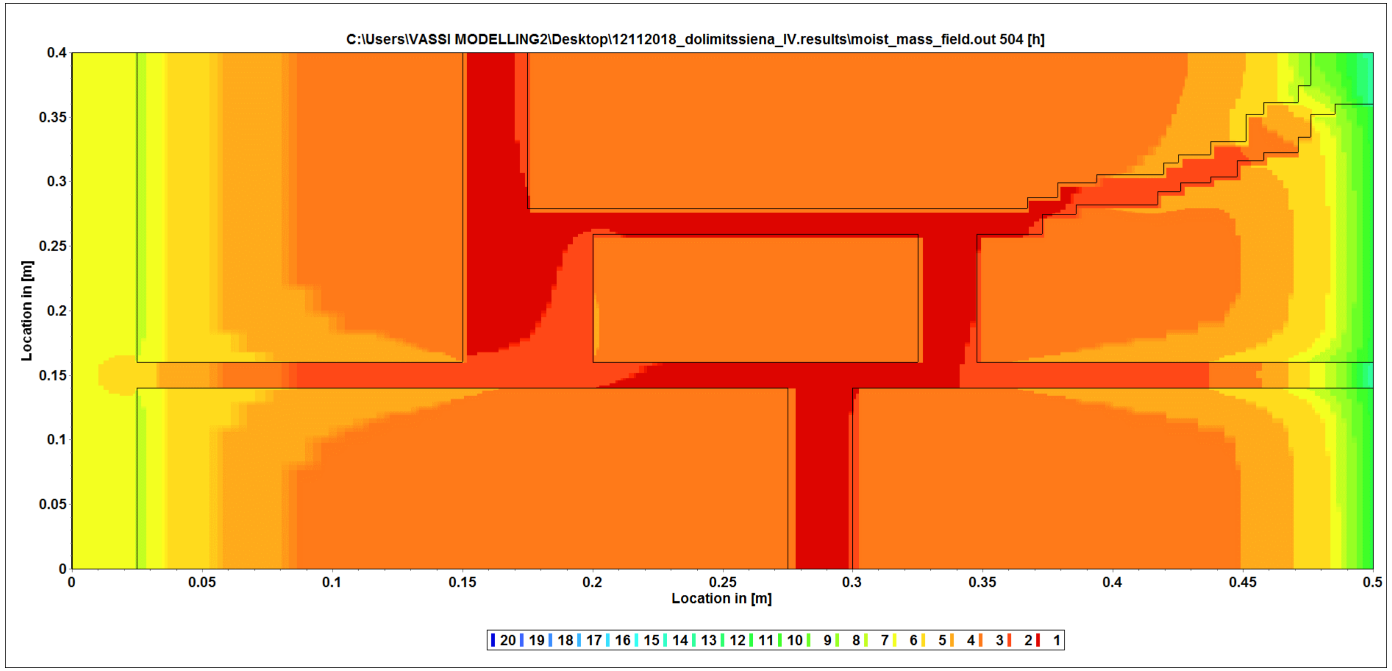
Interdisciplinary research

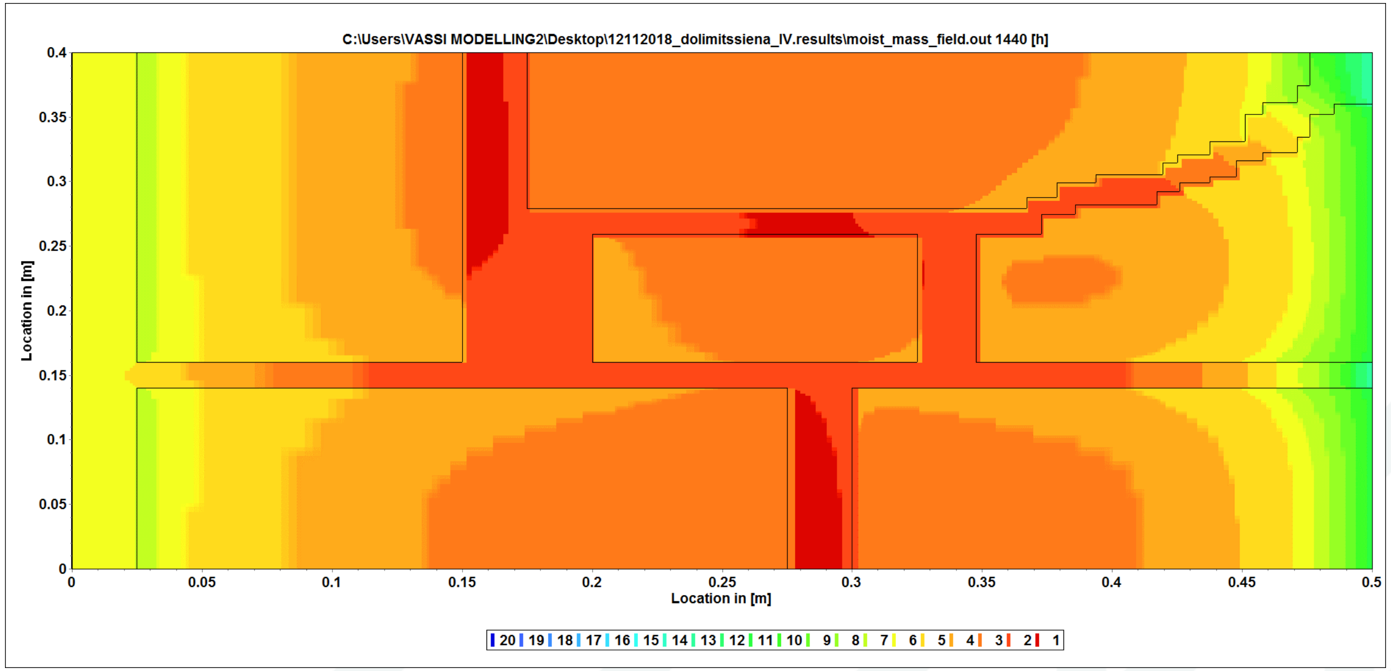


Original wall



Computer simulation with Delphin





Raw material for insulation material

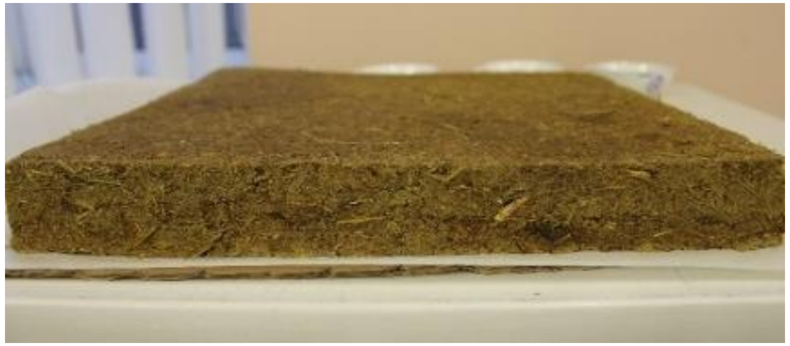
FOREST RESIDUALS

EXTRACTION OF PINE GREENINGS

FRESH GREENINGS OF PINE

+

BINDER



Pine needle insulation material

- Density 58 kg/m³;
- Thermal conductivity 0.051W//m/K

Hygrothermal properties of materials

Laboratory set up

- Indoor:
  - Temperature +20ºC
  - RH 55%
- Outdoor:
  - Temperature 0ºC
  - RH 85%
- 22 days
- Temperature, RH, heat flow metering

Mould growth test of insulation material

- Three moisture levels
- Inserted 5 mould types
- +20°C and darkness
- 20 days

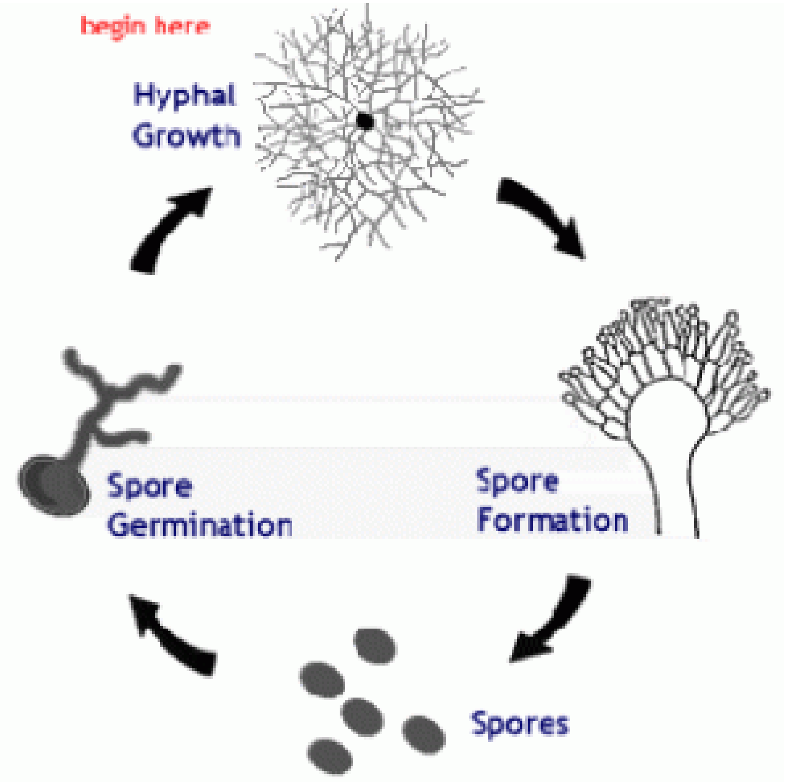
Results

Tests of pine needle insulation in mould growth climate chamber

With lime

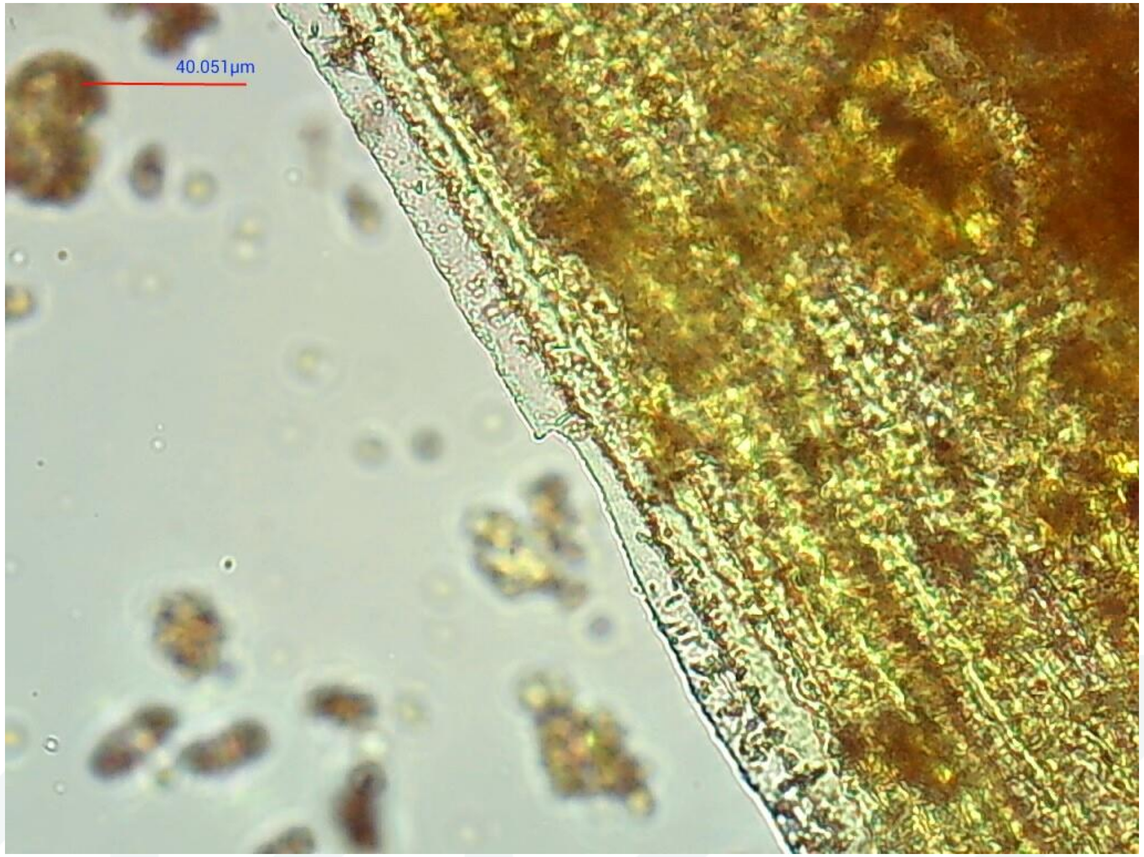
Without lime

Without lime



https://powervacamerica.com/project/life-cycle-of-mold/

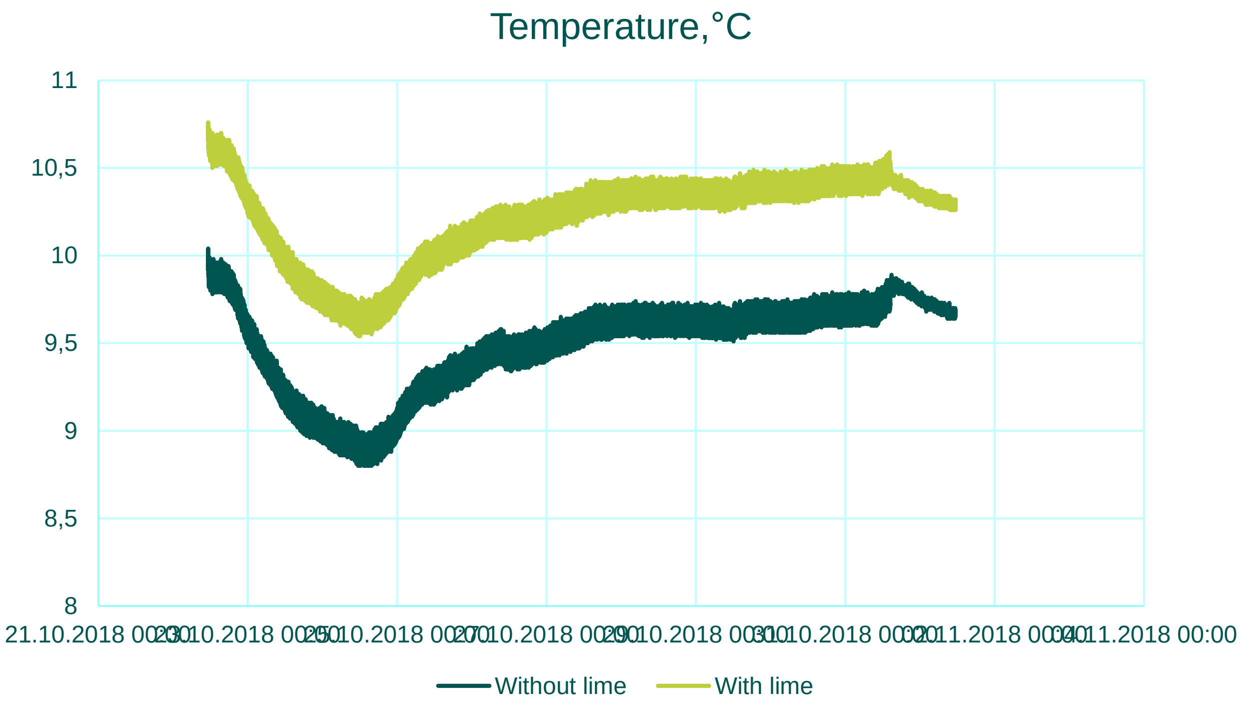
With lime

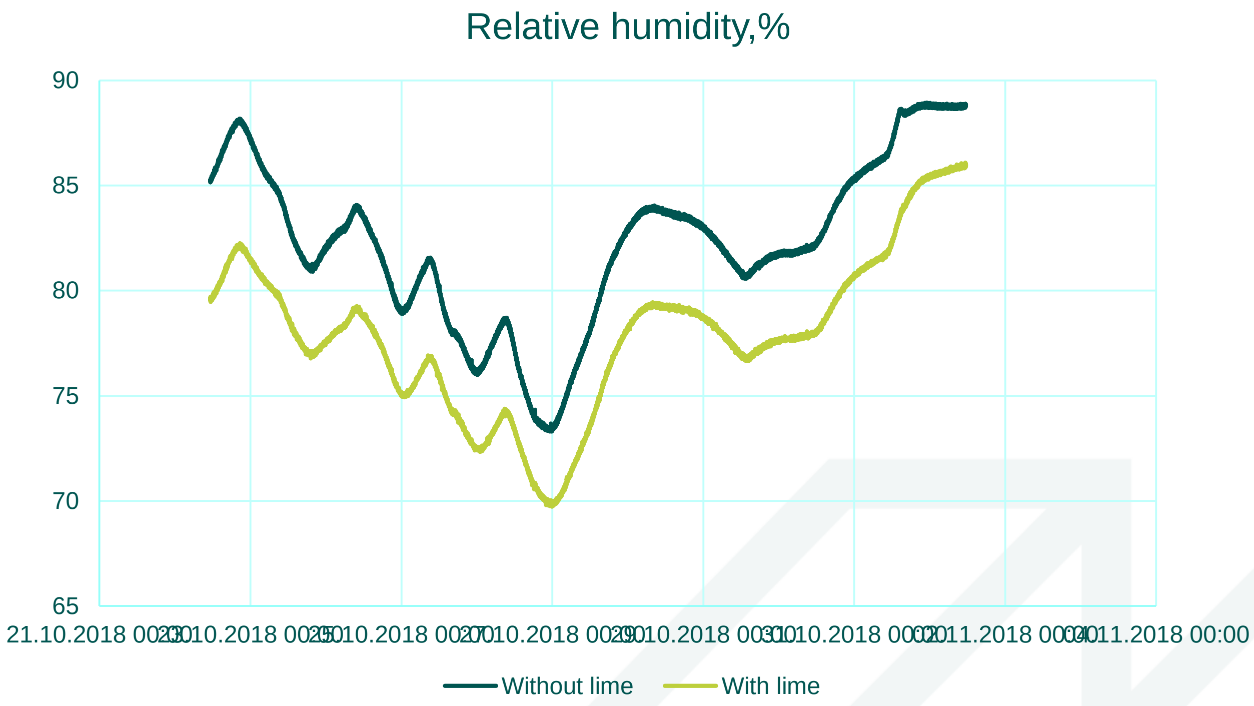


2 ml water and mould mixture

3 ml and 5 ml water and mould mixture

Temperature and RH between stone wall and insulation layer





Conclusions

- Organic insulation material produced from forest residuals has high added value
- Lower temperatures leads to higher relative humidity level
- Heat savings have to be sacrified to reduce failure modes (mould growth) if no lime additive is added
- Relative humidity between insulation and wall reaches critical value for mould growth
- Lime additives does not have impact on thermal conductivity but has impact on mould growth