Interreg
Co-funded by the European Union
Northern Periphery and Arctic

Energy retrofits in northern and Arctic climates: effective solutions, challenges and development needs

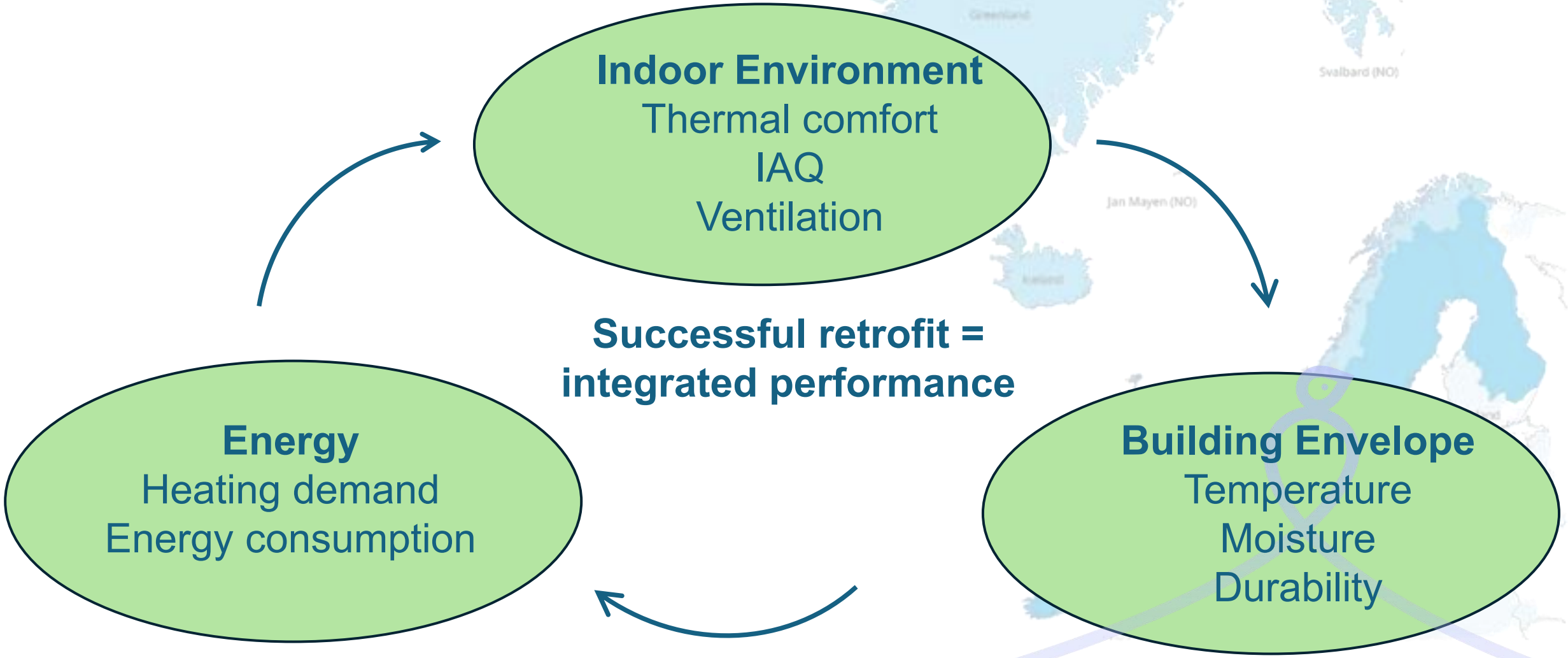
Filip Fedorik & Meriem Filali
University of Oulu

RAKENNUSTERVEYSSEMINAARI
Oulu 7.10.2026

RIAQ - Retrofitting for Improved Air Quality: promoting sustainable and healthy homes

Interreg
Co-funded by the European Union
Northern Periphery and Arctic

Energy retrofit: more than energy savings



Interreg
Co-funded by the European Union
Northern Periphery and Arctic

What can we improve?

Iceland
Sweden
Finland
Ireland

HEATING

VENTILATION

INSULATION & AIRTIGHTNESS

CONTROLS & OPERATION

WINDOWS & DOORS



Interreg
Co-funded by the European Union
Northern Periphery and Arctic

How do we get it right?

BUILDING AS A WHOLE
Combine envelope, ventilation and heating measures

GOOD VENTILATION
Match ventilation to improved airtightness and occupancy

MOISTURE-SAFE DESIGN
Consider how insulation and airtightness change moisture conditions

GOOD DETAILS & EXECUTION
Avoid thermal bridges, air leakage and construction defects

Energy efficiency + healthy indoor environment + durable structures

Interreg
Co-funded by the European Union
Northern Periphery and Arctic

One solution does not fit every building

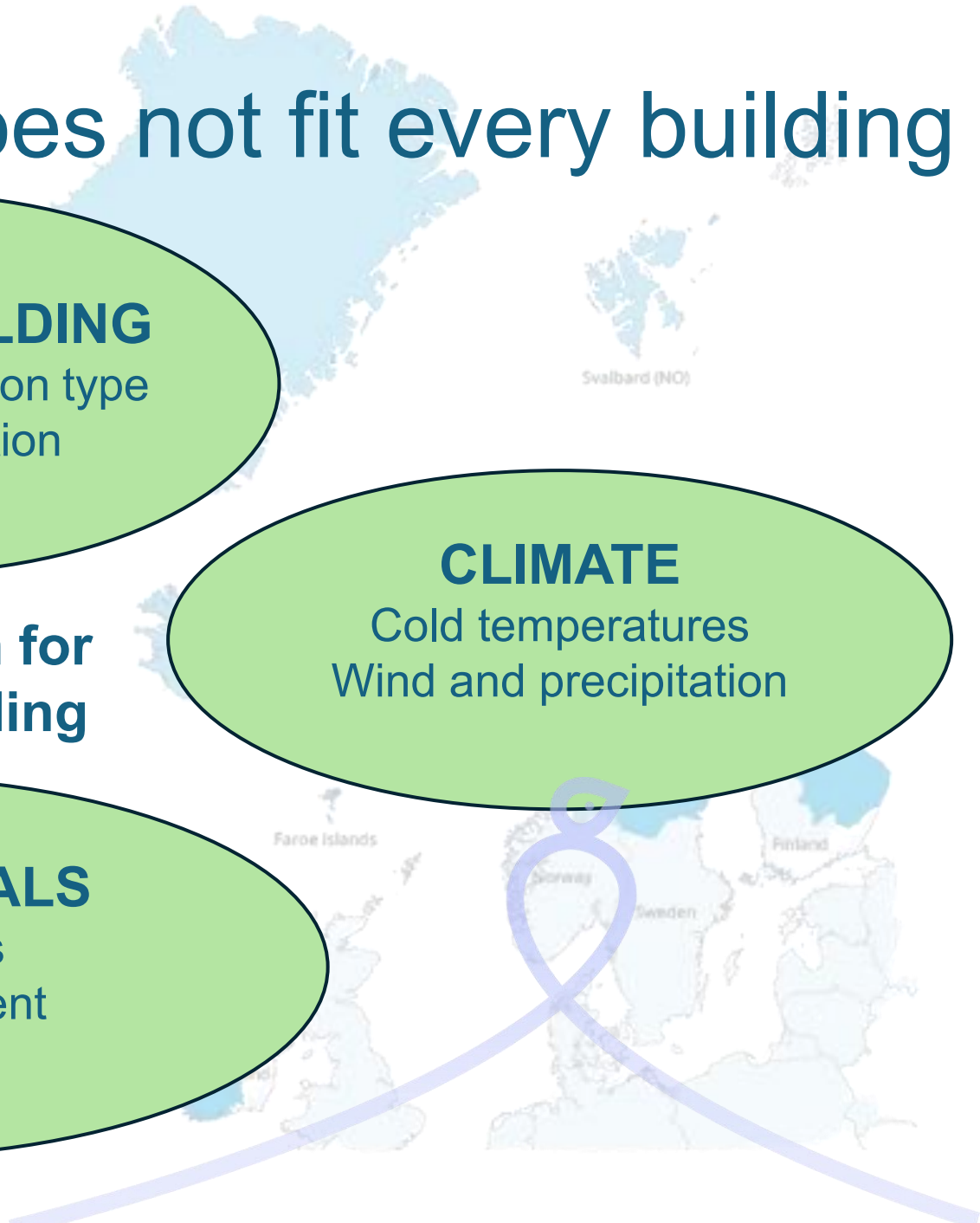
EXISTING BUILDING
Age and construction type
Existing condition

OCCUPANTS
Indoor temperature
Moisture production
Ventilation needs

Right solution for the right building

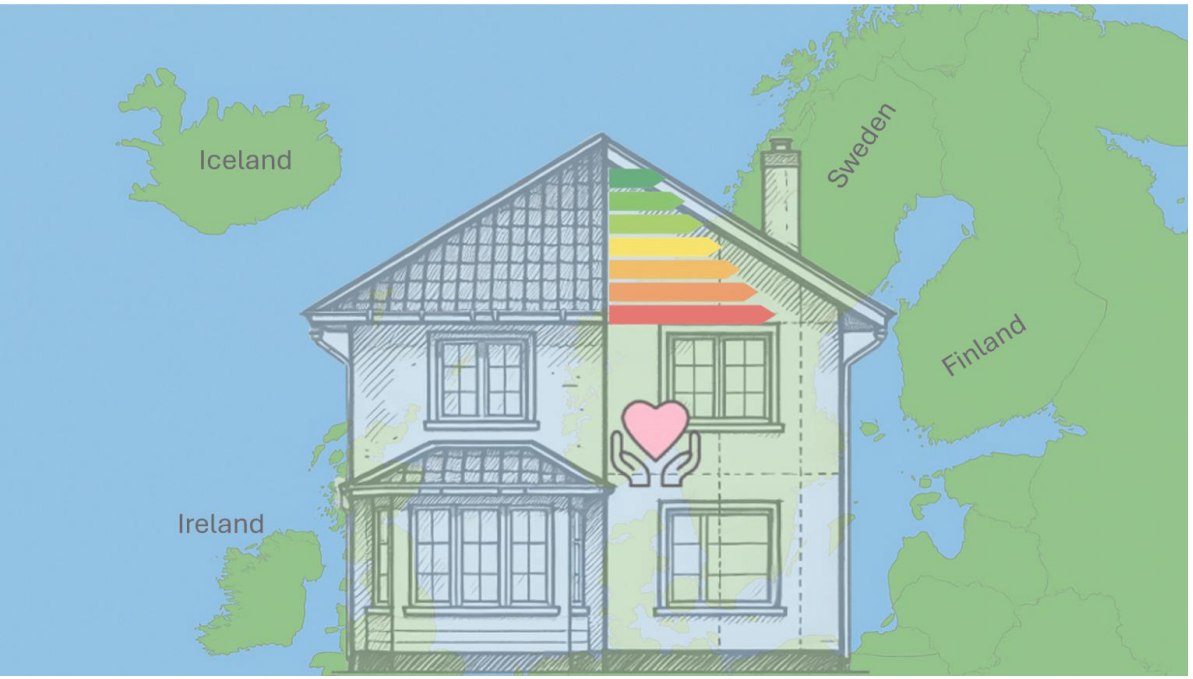
CLIMATE
Cold temperatures
Wind and precipitation

RETROFIT GOALS
Energy savings
Indoor environment
Durability



Interreg
Co-funded by the European Union
Northern Periphery and Arctic

RIAQ: learning from real homes



Before retrofit → Retrofit → After retrofit

Temperature & RH
CO_2
$PM_{2.5}$ / other IAQ parameters



Temperature & RH
CO_2
$PM_{2.5}$ / other IAQ parameters



How does the retrofit affect energy use, indoor conditions and the building envelope?

40 pilot homes across four countries

Finland · Ireland · Sweden · Iceland

Interreg
Co-funded by the European Union
Northern Periphery and Arctic

Real indoor conditions matter for retrofit assessment

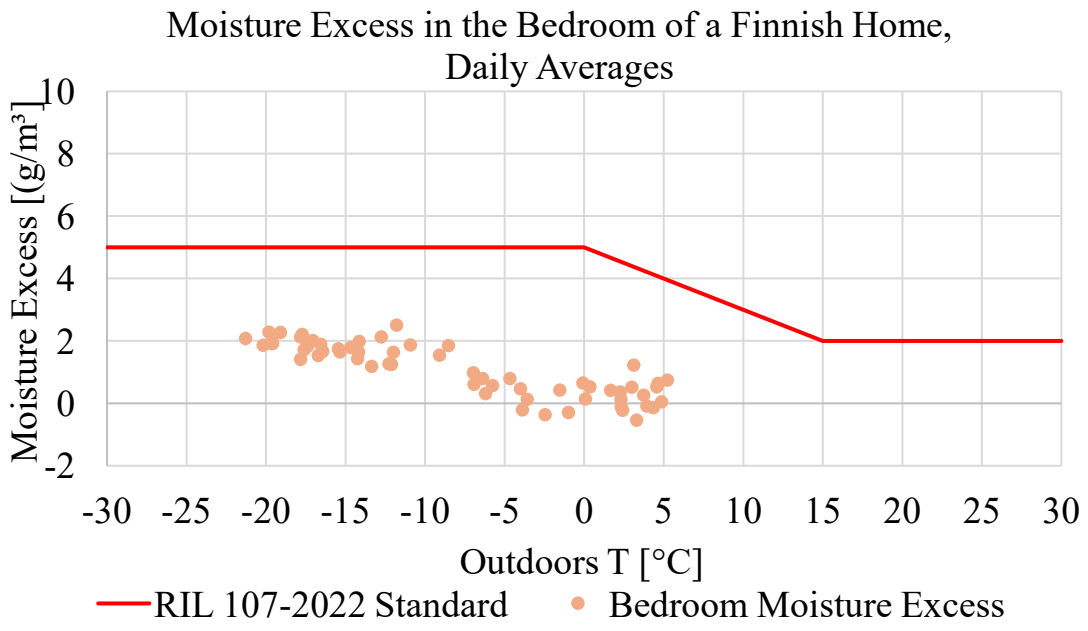
Indoor activities + occupancy + ventilation

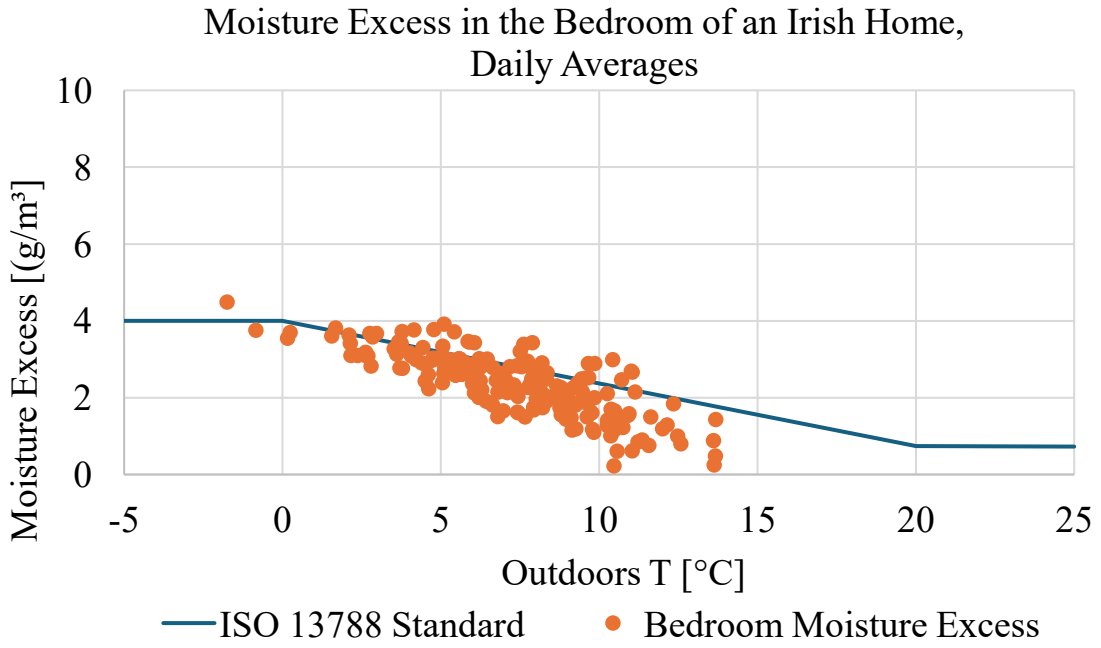
↓

Indoor moisture level

↓

Moisture load on the building envelope





Interreg
Co-funded by the European Union
Northern Periphery and Arctic

From measurements to better retrofit decisions

REAL HOME
Measured indoor conditions

→

BUILDING ASSESSMENT
How does the envelope respond?

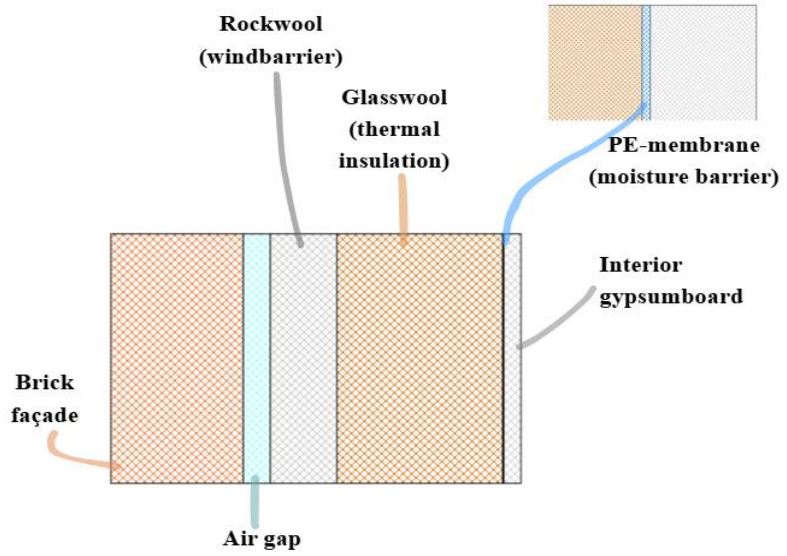
→

RISK ASSESSMENT
Moisture / mould / durability

→

BETTER RETROFIT
Moisture-safe solutions

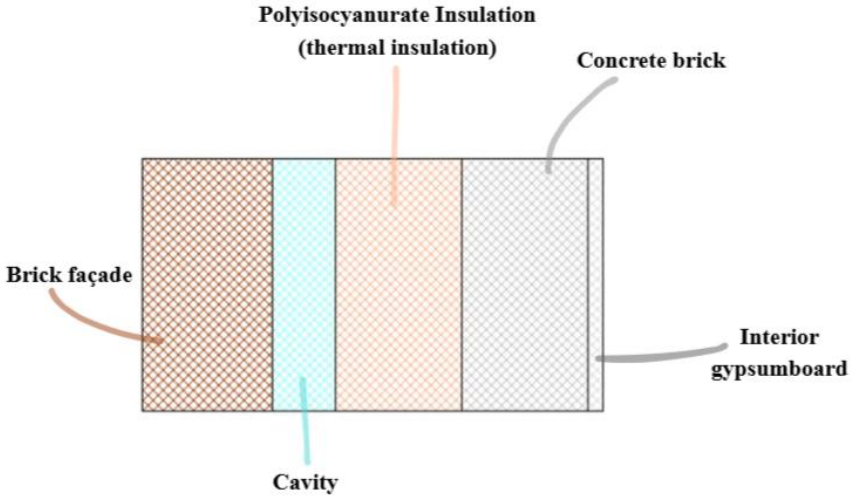
Finland
Pilot-house external wall



Hygrothermal simulation
Measured indoor conditions
+ outdoor climate

conditions within the wall

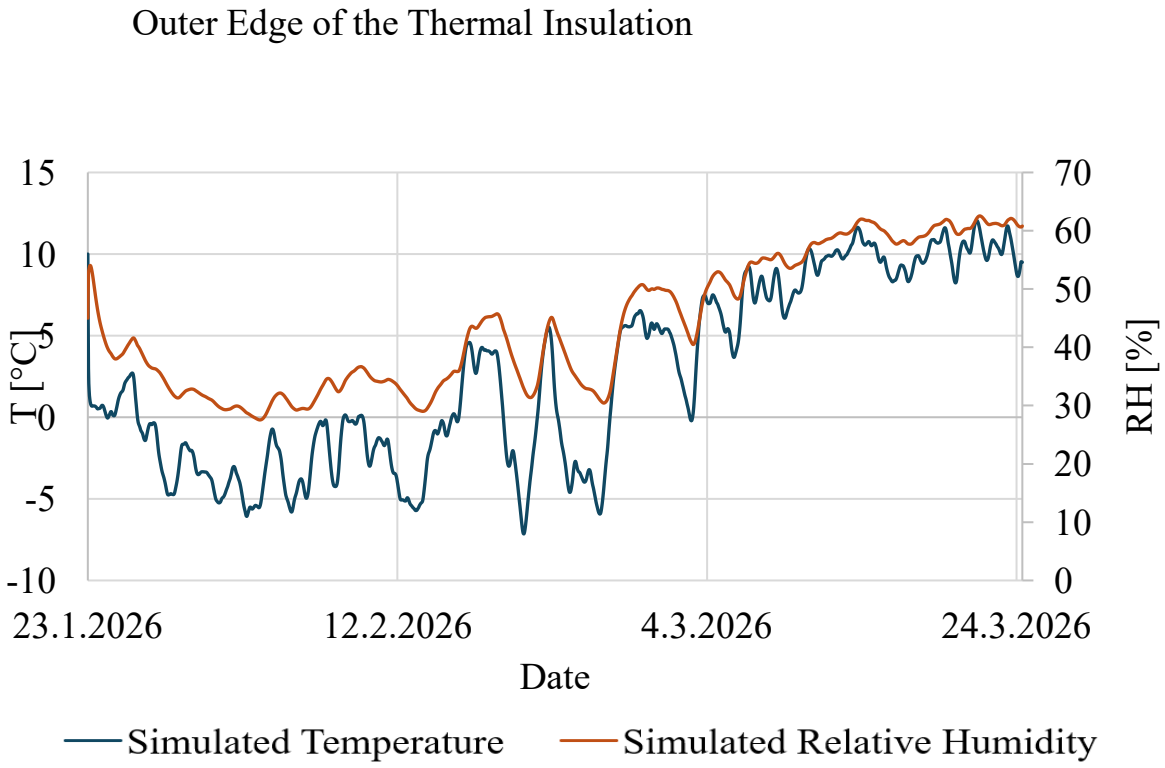
Ireland
Pilot-house external wall



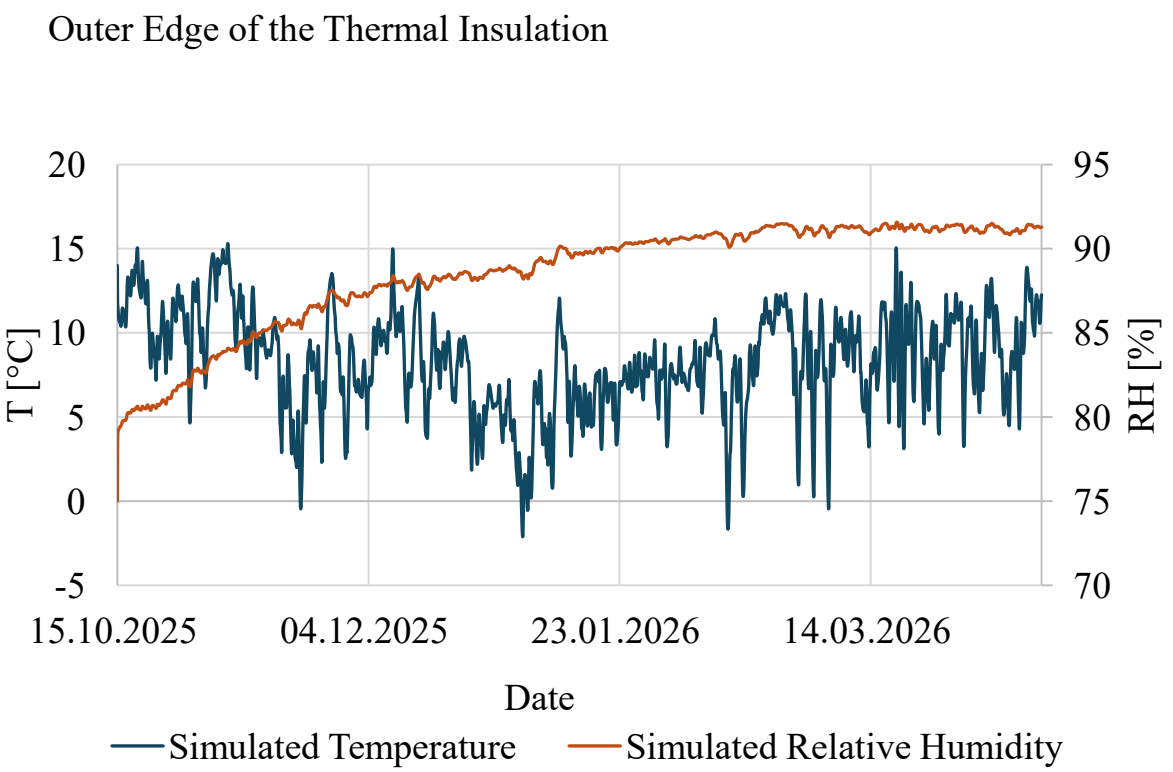
Interreg
Co-funded by the European Union
Northern Periphery and Arctic

Conditions within the external wall

Finland



Ireland



Simulated conditions provide the basis for the mould risk assessment.

Interreg
Co-funded by the European Union
Northern Periphery and Arctic

What do we still need?

REAL-WORLD EVIDENCE
More before-and-after retrofit monitoring

INTEGRATED ASSESSMENT
Energy + indoor environment + durability

BUILDING-SPECIFIC SOLUTIONS
Account for construction, climate and occupants

PERFORMANCE VERIFICATION
Check that the retrofit works as intended

Successful retrofit = energy efficient + healthy + durable

Interreg

Co-funded by the European Union

Northern Periphery and Arctic

Thank you !

