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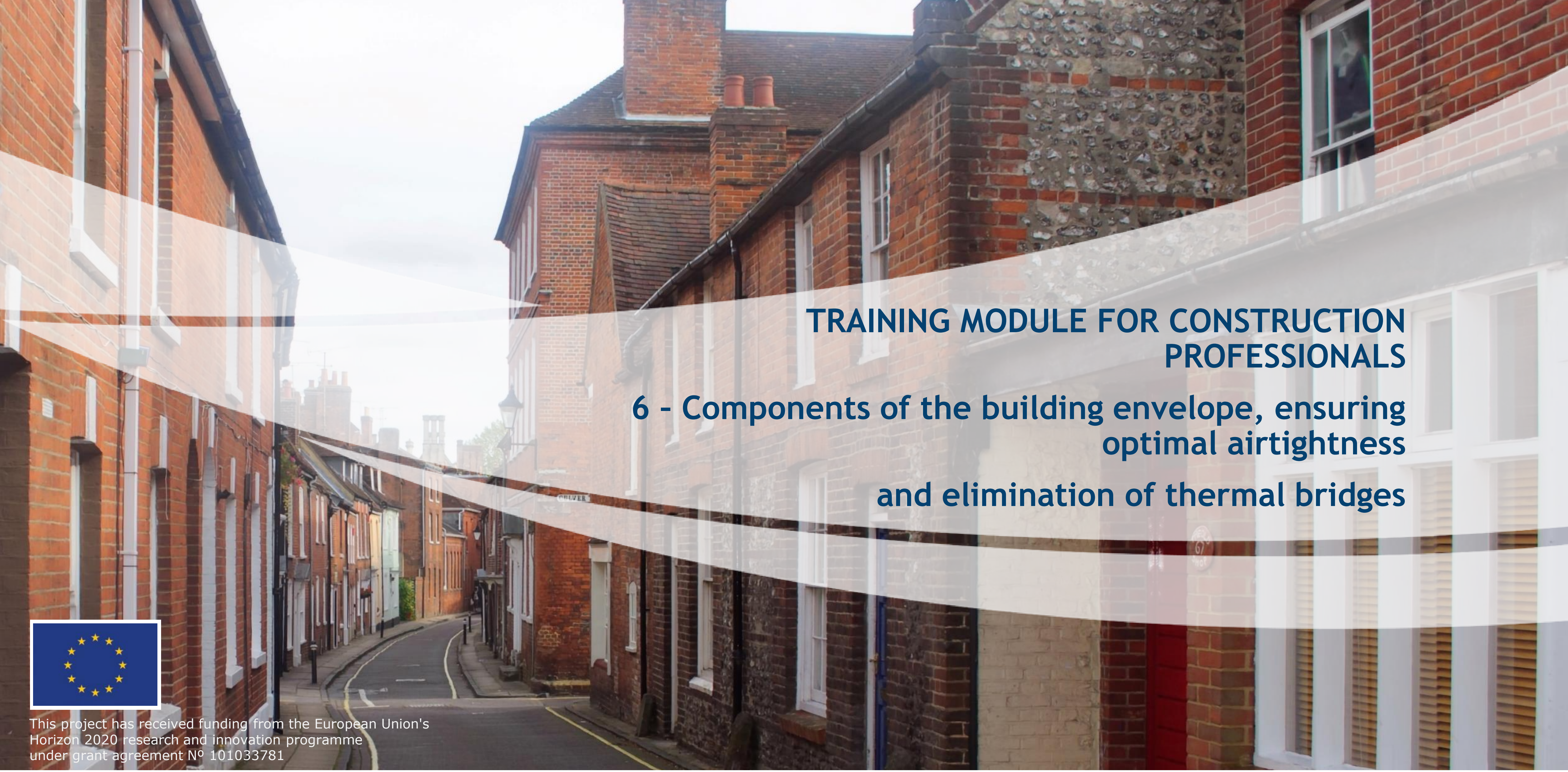
TRAINING MODULE FOR CONSTRUCTION PROFESSIONALS

6 – Components of the building envelope, ensuring optimal airtightness and elimination of thermal bridges

This project has received funding from the European Union's HORIZON 2020 research and innovation programme under grant agreement No 101033781



TRAINING MODULE FOR CONSTRUCTION PROFESSIONALS

6 – Components of the building envelope, ensuring optimal airtightness

and elimination of thermal bridges

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ULO No	Competence	Skills	Knowledge
3	Provide conditions and perform correct installation of components of the building envelope, ensuring optimal airtightness and elimination of thermal bridges	Proper implementation of energy-saving measures on the building envelope Ensuring a continuous thermal insulation layer and airtight envelope, avoiding thermal bridges	Principles of implementation of thermal insulation on walls, floors, roofs Understanding the flow of water vapor through the structure in cold and warm season Knowledge of materials providing airtightness and vapor control Knowledge of the relationship between airtightness, thermal insulation, thermal bridges, and the possible gaps in the application of energy efficiency measures on the building envelope

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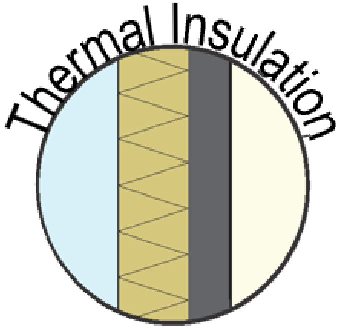
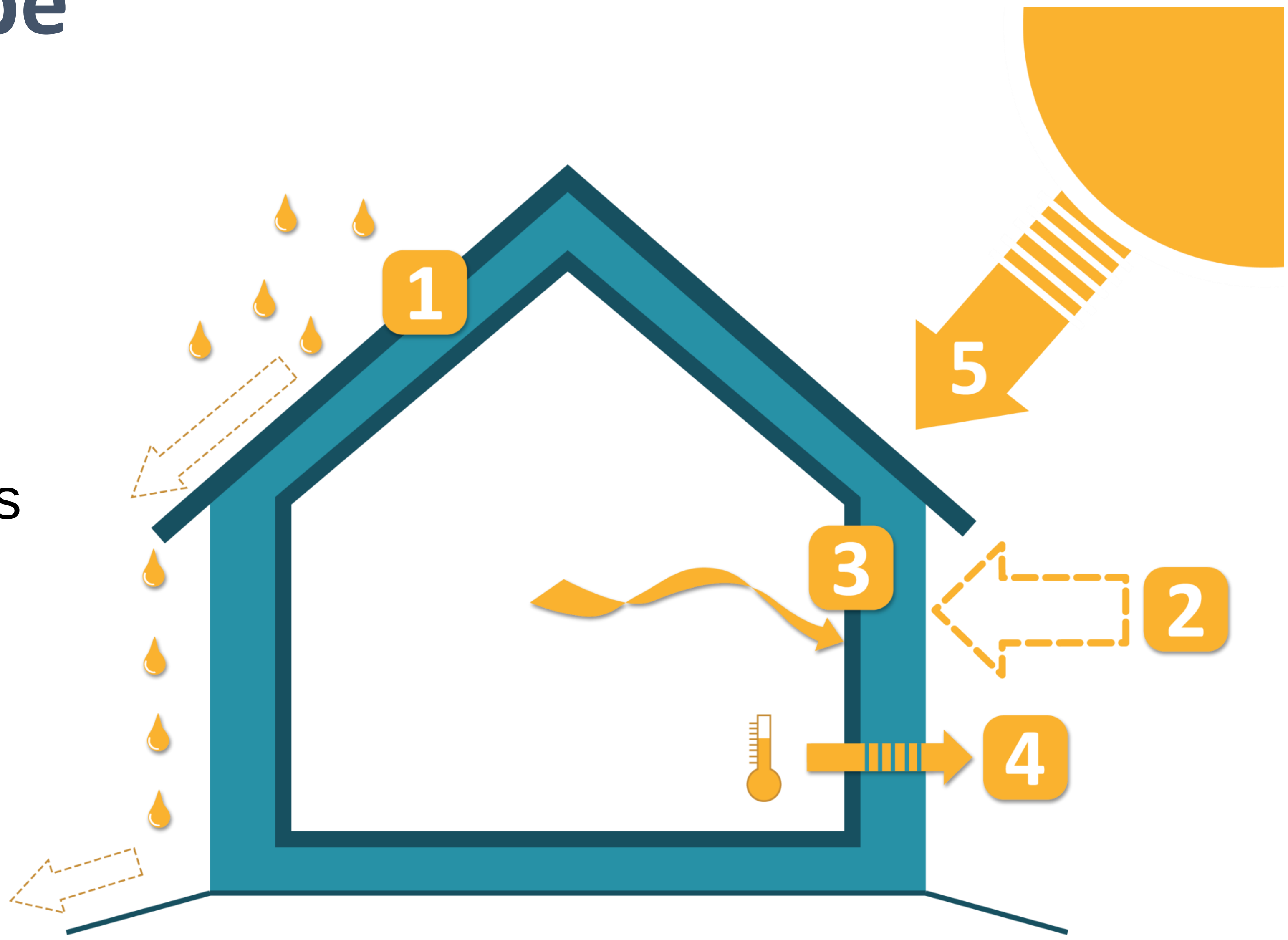
Building envelope

Functions of the thermal envelope:

1. Bulk-water run-off
2. Wind tight protection
3. Insulation & airtightness layer
4. Vapor control layer
5. Prevent overheating





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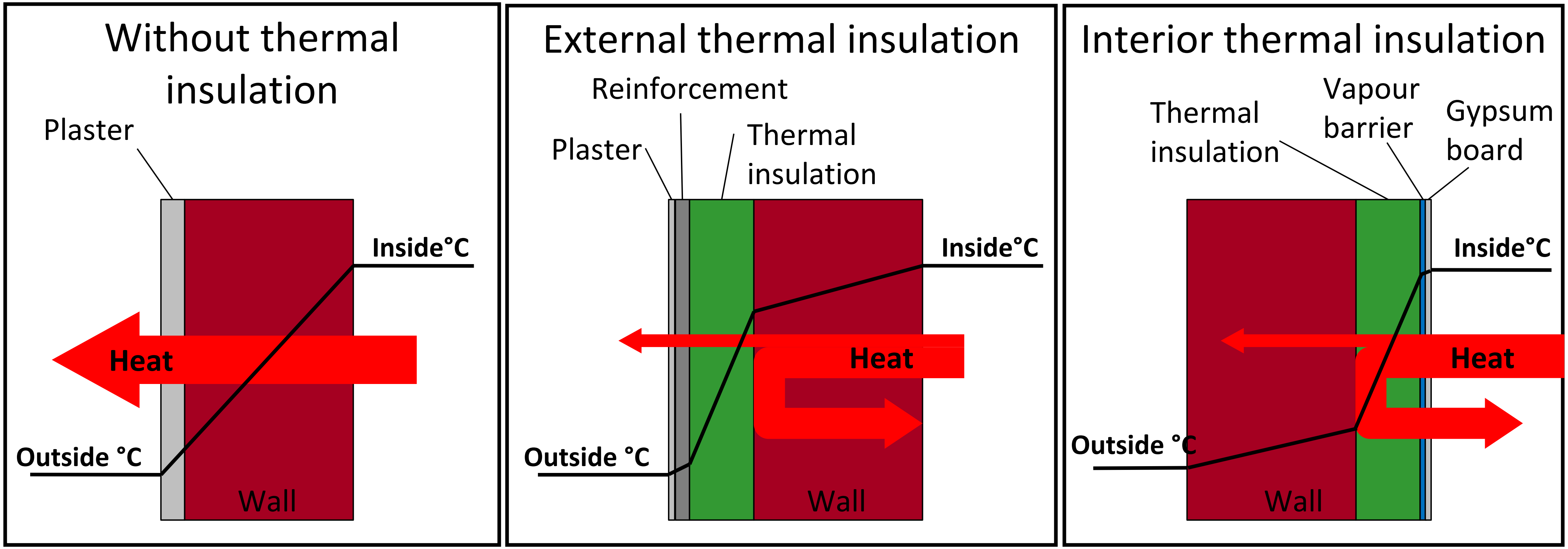
Effect of thermal insulation application (thermal envelope) on heat losses



KEY ADVANTAGES:

- ✓ Reducing heat losses (or gains) → decreasing the energy demands of heating and cooling
- ✓ Healthy indoor climate

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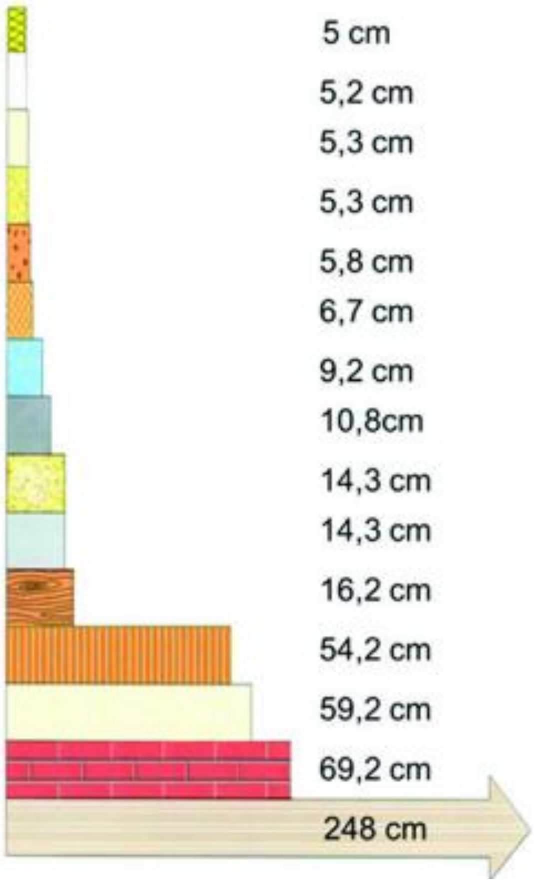
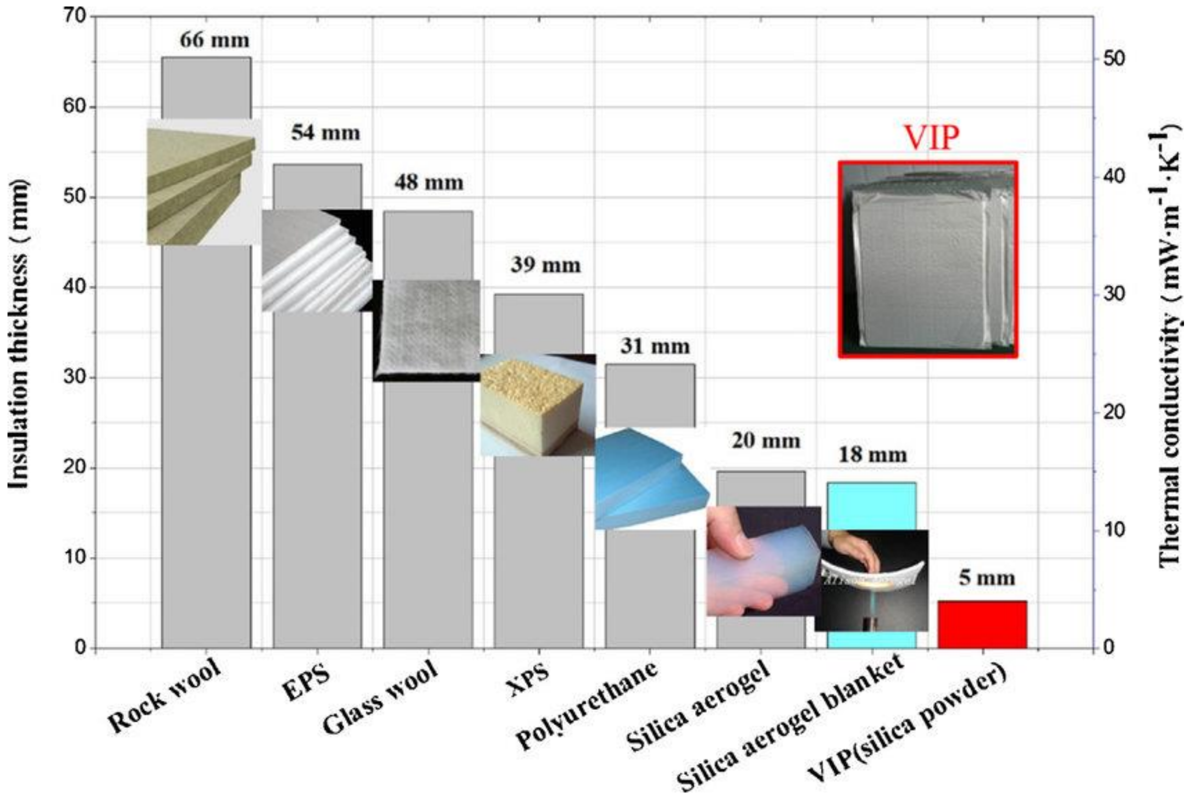
Different thermal insulation materials

Mineral wool
EPS
Sheep wool
Celulose
Cork
Coke
Clay
Wood fibres
Chipboard
Perlite
Timber
Hollow brick
Concrete block
Full brick
Reinforced concrete





Liang, Y. et al. [6]

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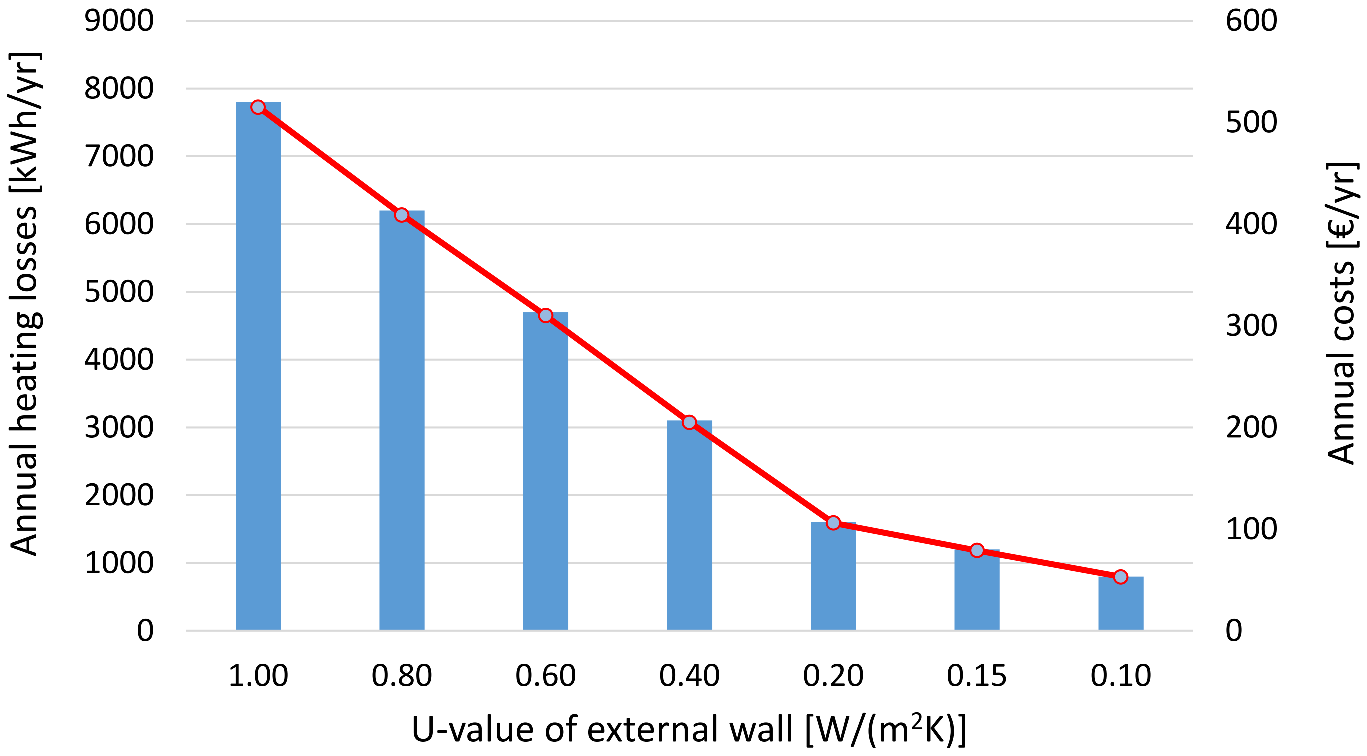
Potential for energy and financial saving



Example of a small single-family house with an external wall surface of 100 m²

Passipedia [10]

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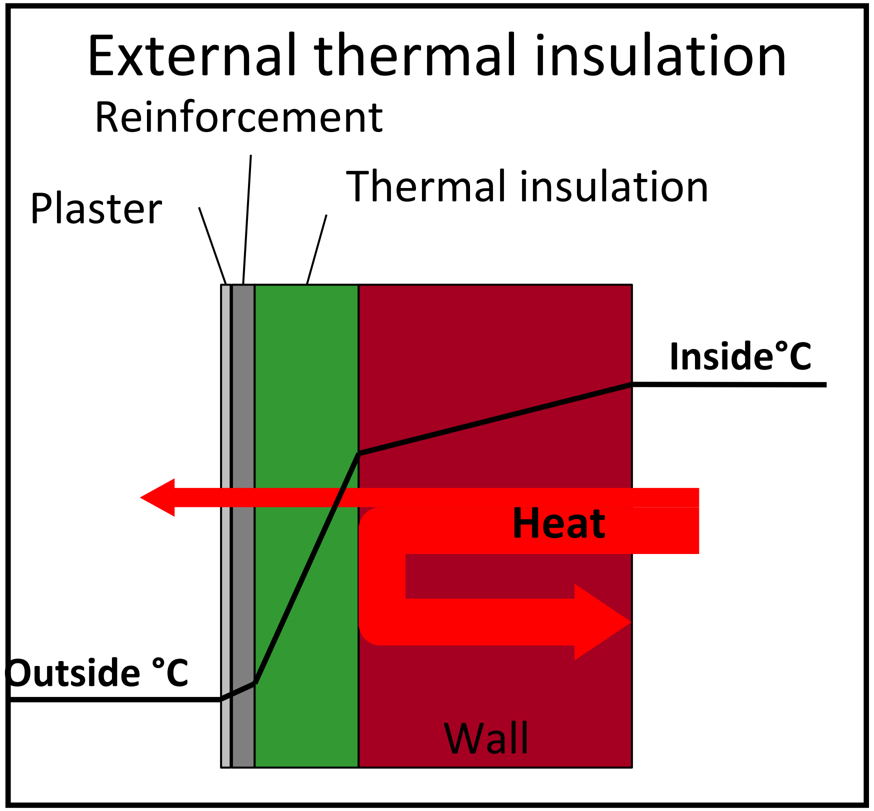
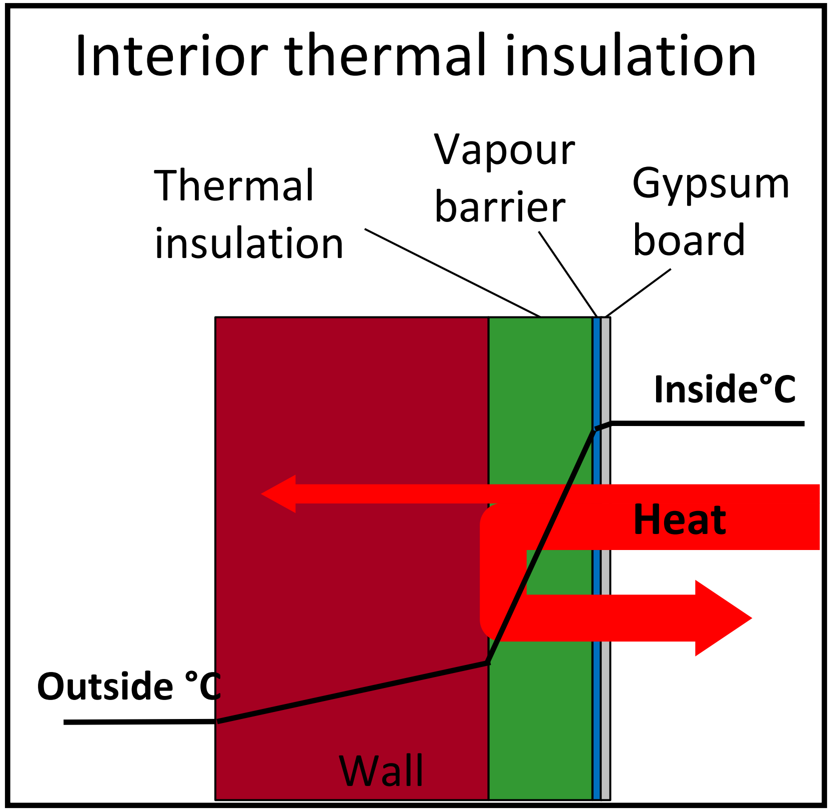
External vs. Interior thermal insulation

Disadvantages of interior insulation:

- ✓ Risk of condensation – vapour barrier
- ✓ Thermal bridges
- ✓ No heat accumulation in winter
- ✓ Overheating in summer
- ✓ Unprotected external wall
  Risk of freeze/thaw, etc.
- ✓ ''unfavorable'' position of thermal
  insulation in winter and summer





Advantages of interior insulation:

- ✓ Fast heating of interior space
- ✓ Buildings under cultural heritage protection

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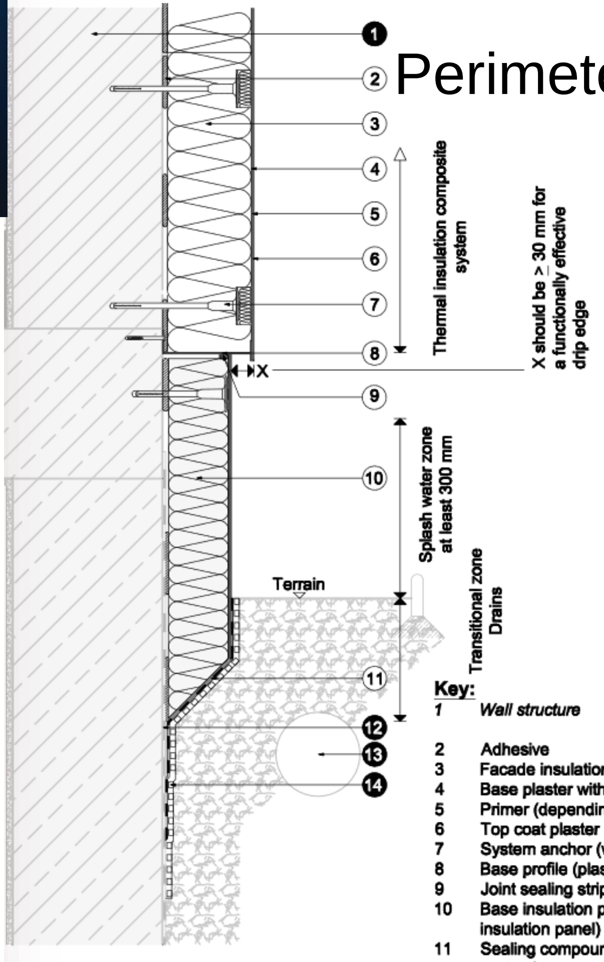
- **External thermal insulation – Foundations & Floors**

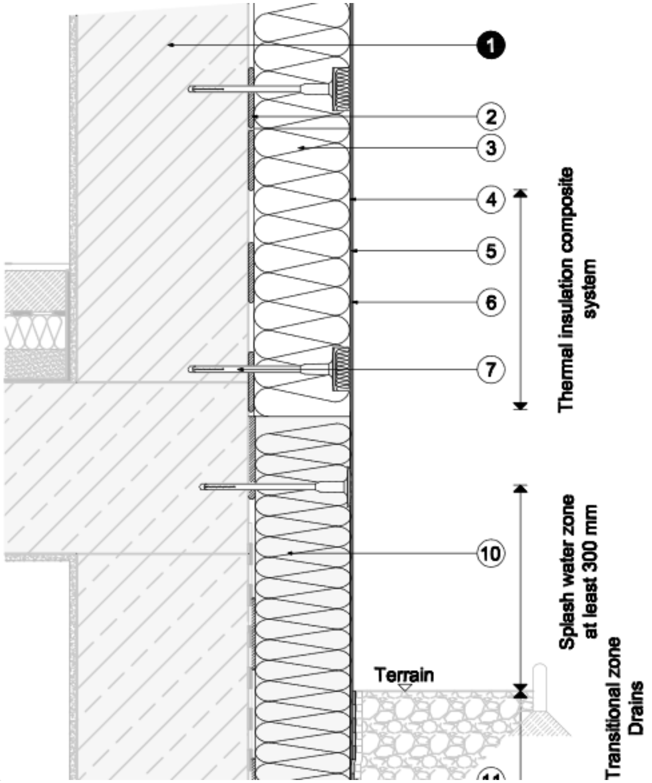
Insulation of existing foundations

Perimeter insulation – transition from the facade to the base area



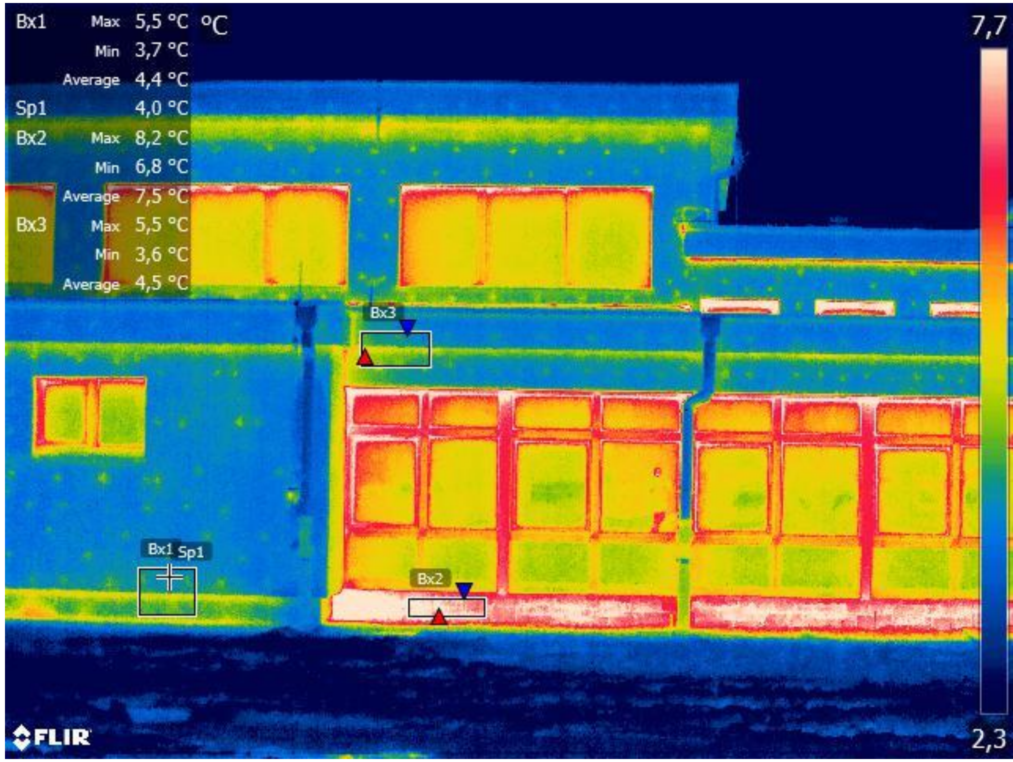
Key:
1 *Wall structure*
2 Adhesive
3 Facade insulation panel (EP
4 Base plaster with reinforcem
5 Primer (depending on syste
6 Top coat plaster
7 System anchor (with plug/flu
8 Base profile (plastic)
9 Joint sealing strip
10 Base insulation panel (perimeter insulation panel)
11 Sealing compound (depending on system)
12 *Existing sealing of building structure*
13 *Drain*
14 *Delta membrane or similar*

Undercut base



Flush base

EAE [29]



- Take care of thermal bridges!
- Material choice – XPS or foam glass

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• **External thermal insulation – Foundations & Floors**

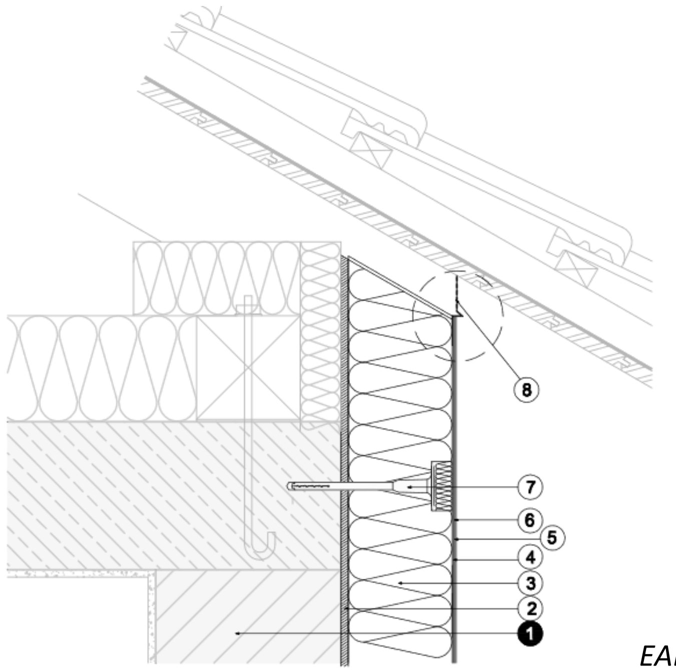
Floors that need to be thermally insulated

- ✓ Cold attic floor
- ✓ Floor above unheated basement
- ✓ Floor above surrounding external air
- ✓ Ground slabs

YTONG [33]

Maistor Plus[34]

HUPFAS [32]



Key:
1 *Wall structure*
2 Adhesive
3 Facade insulation panel (EPS/MW)
4 Base plaster with reinforcement
5 Primer (depending on system)
6 Top coat plaster
7 System anchor (with plug/flush)
8 Roof connection profile

EAE [29]

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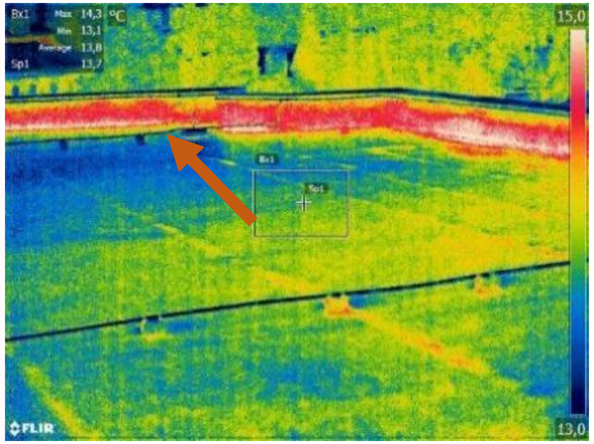
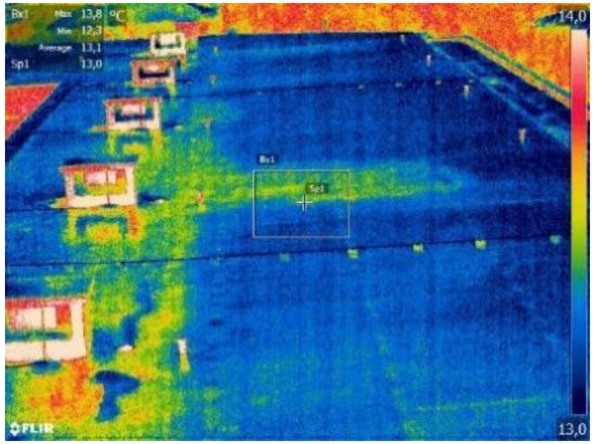
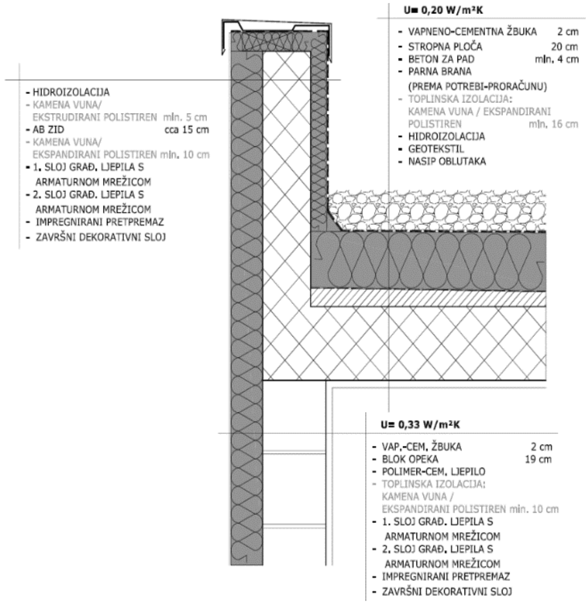
Insulating flat roofs

HUPFAS [32]







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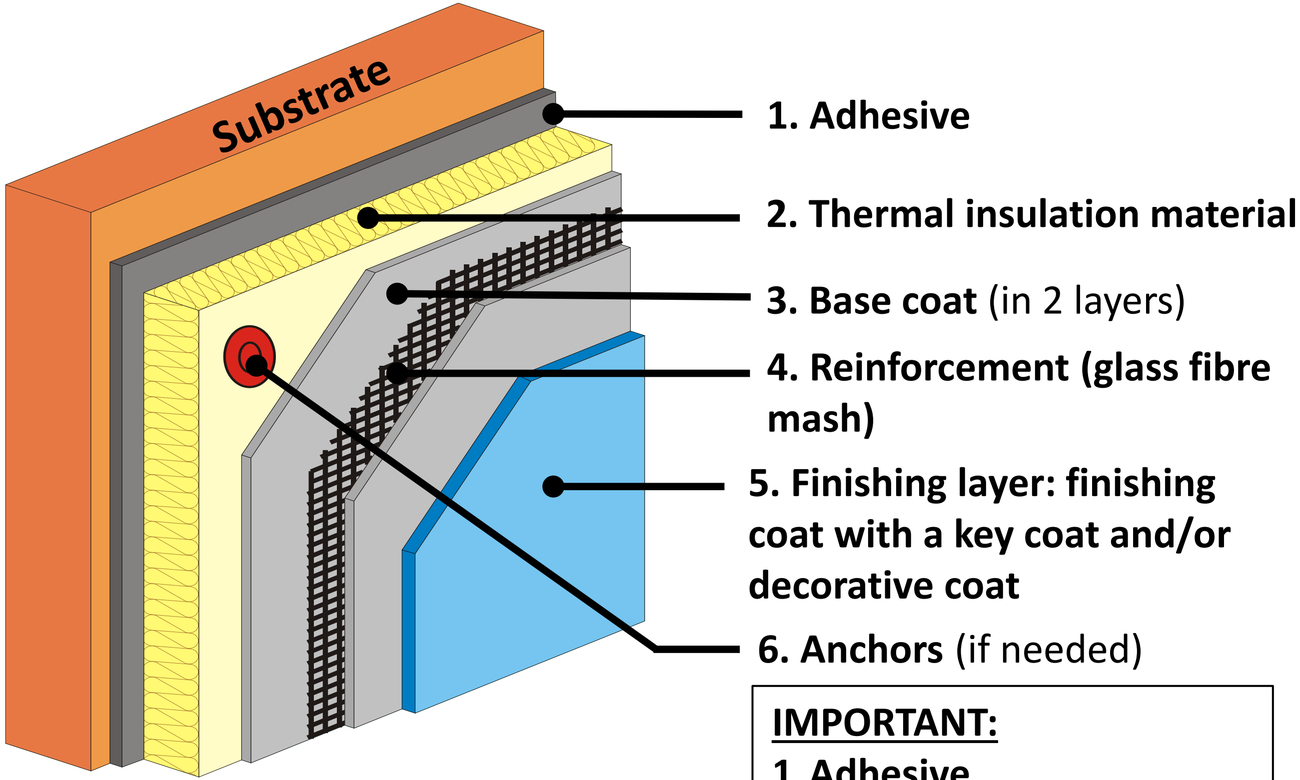
ETICS systems (External Thermal Insulation Composite System)

One of the most commonly used systems for thermal enhacement of walls.

Thermal insulation material	Advantages	Disadvantages
Stone wool	•<u>Vapour permeable</u> •Good reaction to fire •Good sound insulation	•15-30% more expensive •More demanding for installation •Risk of damping
EPS-polystyrene	•Lower material price •Easier for installation •Greater choice of finishing layers	•<u>Less vapour permeable</u> •Weaker sound insulation •Weaker reaction to fire



<u>IMPORTANT:</u>

1. **Adhesive**
2. **Reinforcement**
3. **Finishing layer <u>have to be from the same producer</u>**

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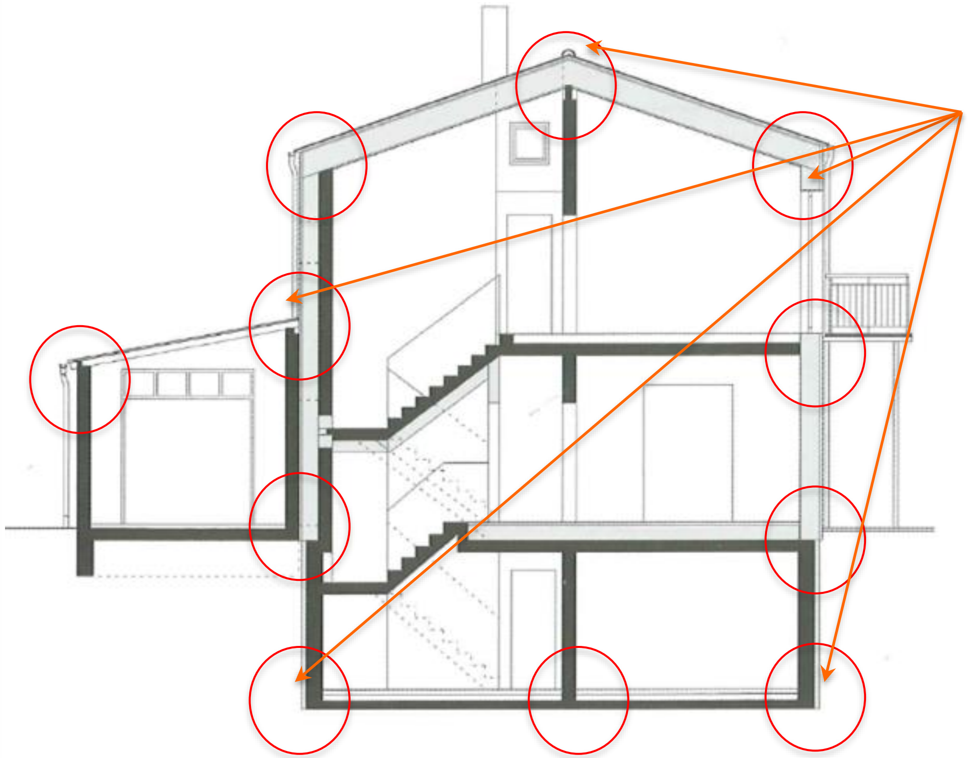
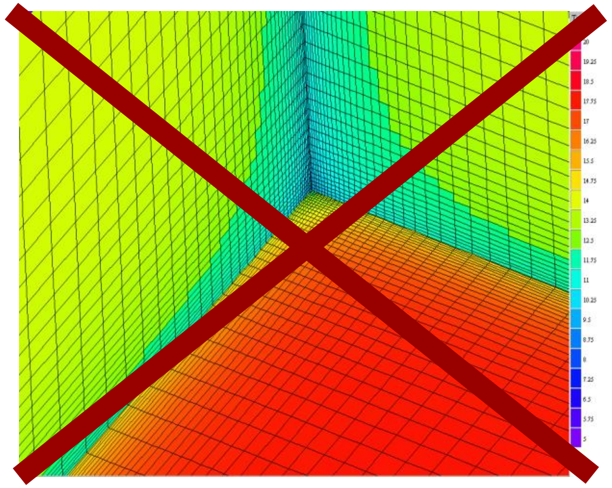
Thermal bridges



Source: Passive House Institute, Germany

All weak spots in the thermal insulation of the building envelope are thermal bridges



Thermographic image of a thermal bridge (from the inside)

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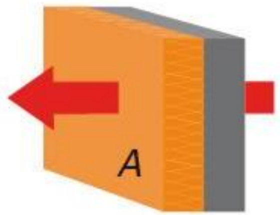
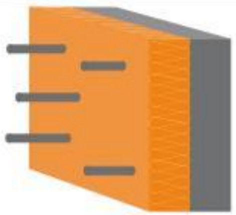
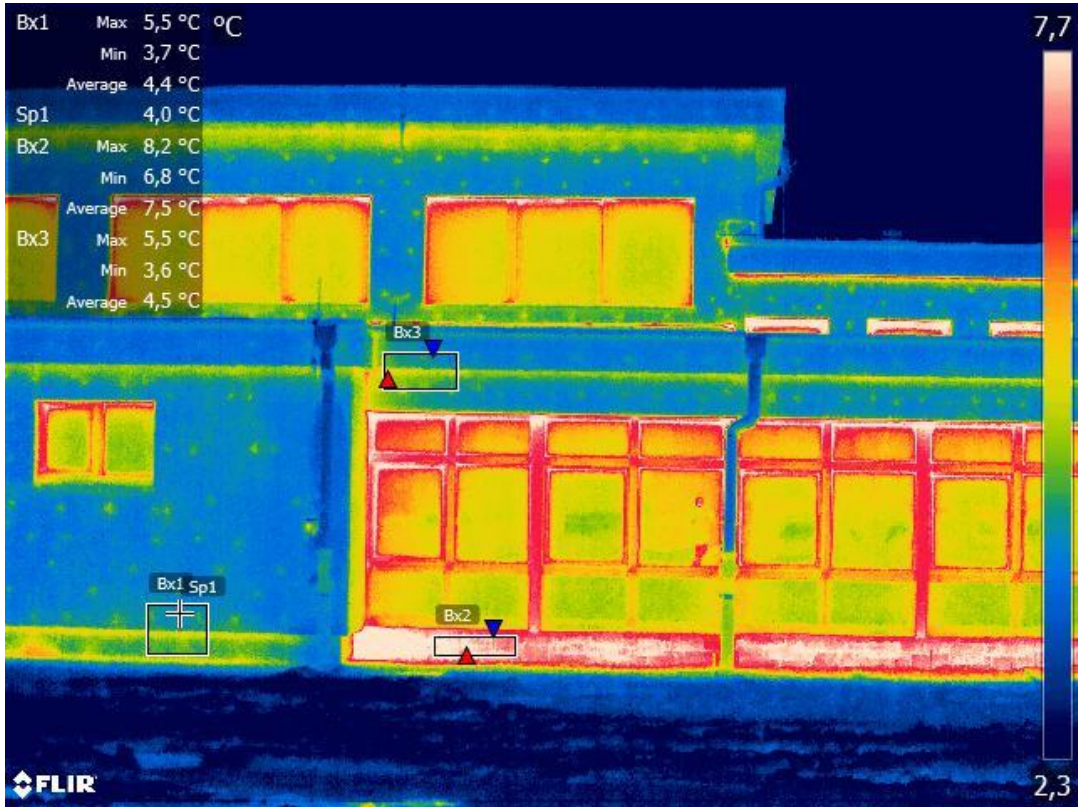
Thermal bridges







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Thermal bridges

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Benefits of Airtightness

- ✓ Eliminates drafts
- ✓ Improves comfort
- ✓ Reduces heat losses
- ✓ Reduces heating bills
- ✓ Improves sound proofing
- ✓ Increases efficiency of the ventilation system

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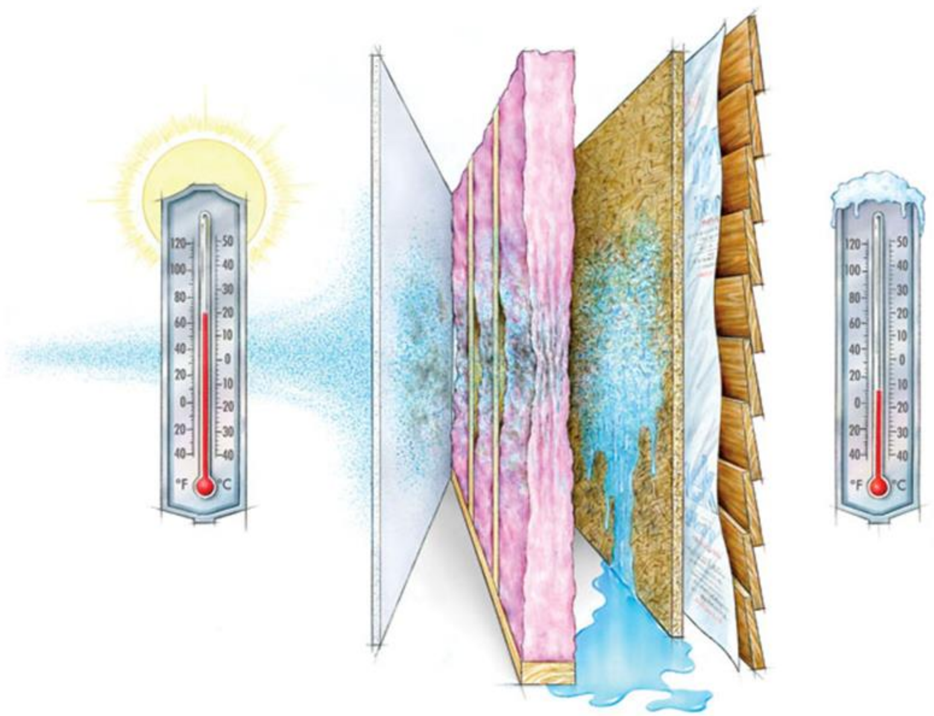
Benefits of Vapour Control

- ✓ Prevent vapour-laden air escaping into the exterior envelope
- ✓ Create vapour-open exterior face to allow envelope to ‘breathe’ to the outside
- ✓ Reduce risk of condensation and mould in the envelope
- ✓ Protect structural integrity
- ✓ Reduce risk of adverse health effects from mould



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Benefits of Windtightness

- ✓ Breathable but wind-tight layer located on the wall exterior
- ✓ Reduced impact of wind on the performance of the building
- ✓ Improved performance of the insulation layer (the heat is not blown away by the wind)
- ✓ Reduced heat losses and energy bills
- ✓ Improved comfort
- ✓ Especially important with ‘loose’ insulation such as cellulose or mineral wool

Image: Foursevenfive.com

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Vapor Barries versus Vapor Retarder

Vinyl and plastic are vapour ‘barriers’ which will never let the moisture in these assemblies dry out to the inside when moisture gets in

Vinyl wallpaper – Mould due to inwardly driven moisture trapped by the vapour impermeability of the vinyl wallpaper

Interior polyethylene vapour barrier should never be used. The above image shows trapped condensation from inwardly driven moisture

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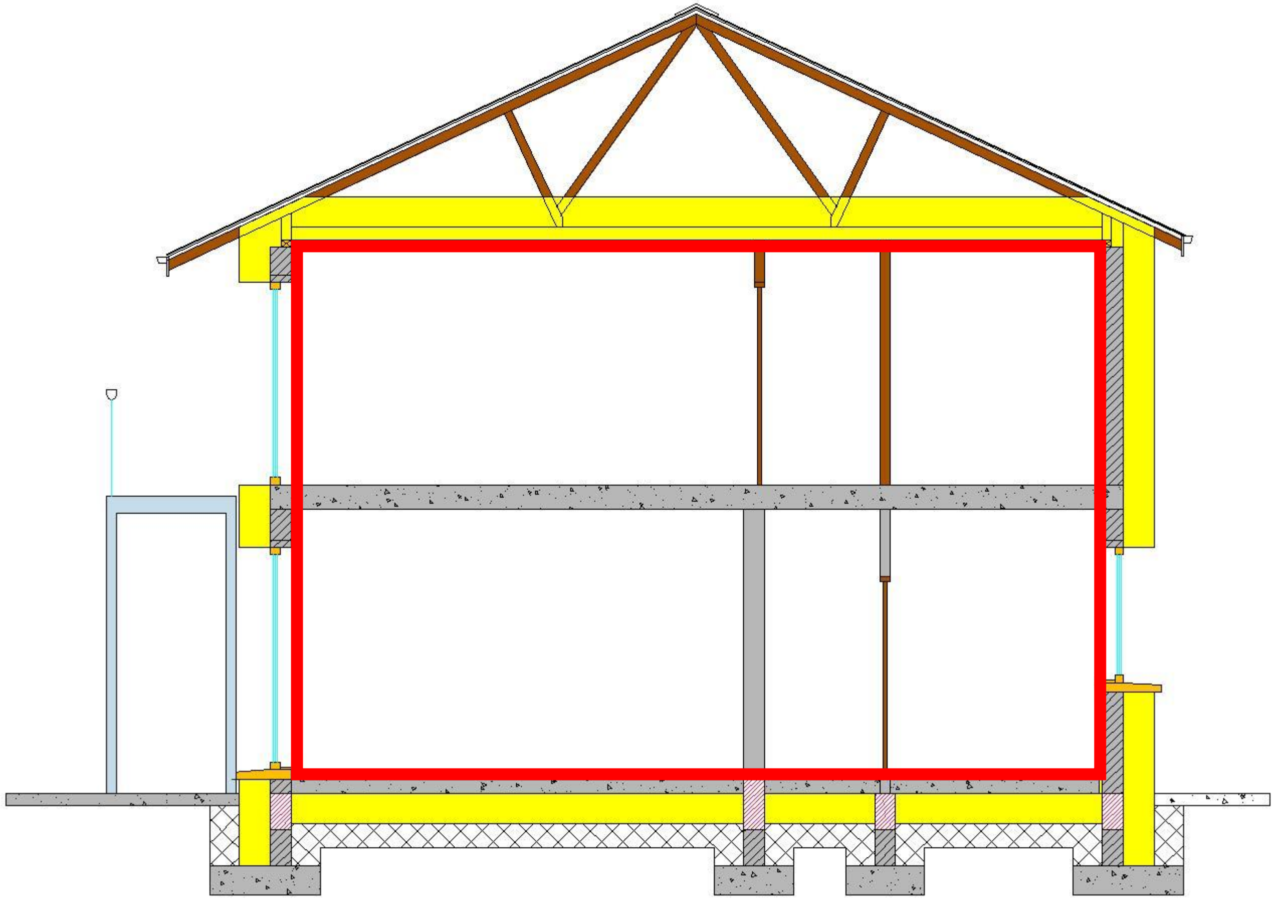
Airtightness: One continuous airtight layer

- ✓ At the design stage, draw a continuous ‘red-line’ all around the building envelope to identify tricky junctions and connections
- ✓ Decide on one airtight layer (not multiple layers which might not be connected)
- ✓ Best placed on the warm side of the insulation layer
- ✓ Can also assist with vapour control
- ✓ Must be without gaps, tears or penetrations
- ✓ Use materials with proven long-term performance



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Airtightness – Planning

- ✓ Decide where the airtight layer should be
- ✓ Minimise penetrations
- ✓ Minimise number and length of connections
- ✓ Check construction drawings (continuous airtight envelope)
- ✓ Define materials and connection details
- ✓ Make detailed drawings to communicate the working instructions on-site
- ✓ Ensure everyone on-site is aware of the airtightness strategy
- ✓ Consider the durability of materials and connections

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Airtightness – Planning

- OSB → Membranes and tapes
- Membranes → Tapes
- Concrete → Plaster, Screes and Tapes
- Bricks → Plaster

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Typical Weak Points in Airtightness Detailing

Bunched service penetrations fit tightly to corners which cannot be individually taped or sealed

Bunched service penetrations in a floor which cannot be sealed individually

Multiple services passing through wood without specialist airtight grommets

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Typical Weak Points in Airtightness Detailing

Floor to wall junctions, where surfaces are rough and preparation is essential

Window to wall connections

Attic hatches

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Non-Airtight Materials

Unplastered brick or block

Some kinds of OSB Board

Insulation boards & tongue & groove cladding

Some kinds of spray foam

Plasterboard

Duct tape

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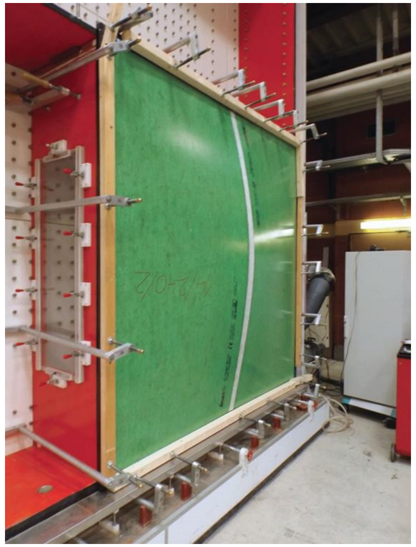
Airtight Materials

Plastered brick or blockwork

Specialist tapes and membranes



Certified airtightness boards

Image: SmartPly

Specialist liquid applied membranes

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Taped Connections Between Masonry Walls and Floors

Remove dust and debris and apply primer prior to affixing tape

Apply appropriate tape

Image: SmartPly

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Connections Between Ceiling and Walls

Image: SmartPly

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Making Airtight Window Connections

Step 1:
Plasterable tape used to connect window reveal to window frame

Step 3:
Applies decorative finishes

Source: 29

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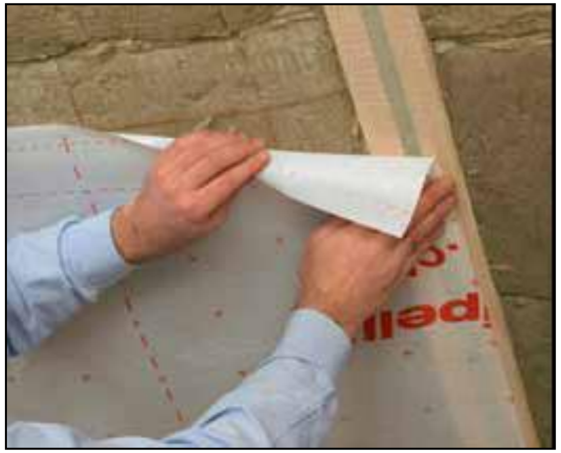
Using Membranes to Seal Roof Underside






Source: SIGA

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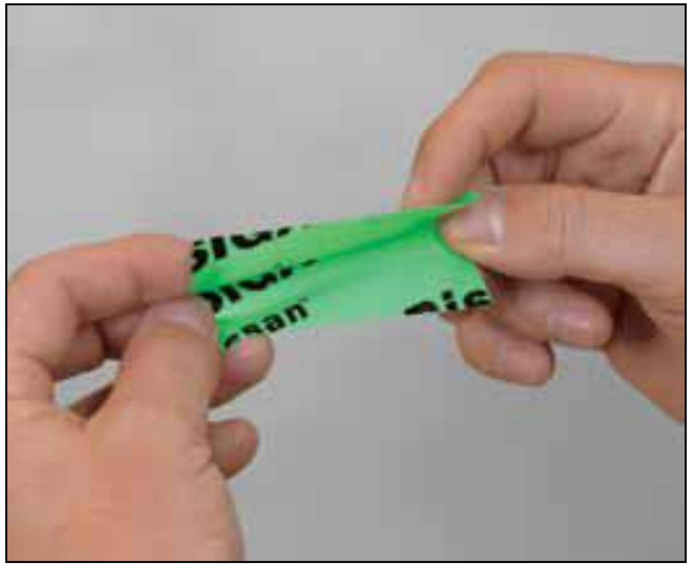
Improvised Sealing of Penetrations without Grommet



1. Cut short **strips of flexible tape** (which can be formed around bends)
2. Tape the penetration all around piece by piece (no rounding of connection – 90 degrees)
3. Ensure good overlap between each piece, with no gaps

Source: SIGA

Verify performance during the airtightness text

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Risks in implementing a stepwise approach considering building envelope

Connection between the thermal insulation and thermal insulation in future steps

- Future connection should be without thermal bridge
- Airtightness layers should be planned to be connected during next step
- Installation of windows should be connected to the future wall
- Future penetration trough airtight element from pipe, cables or others
- Future installation of lamps, shading devices or others on the already insulated element

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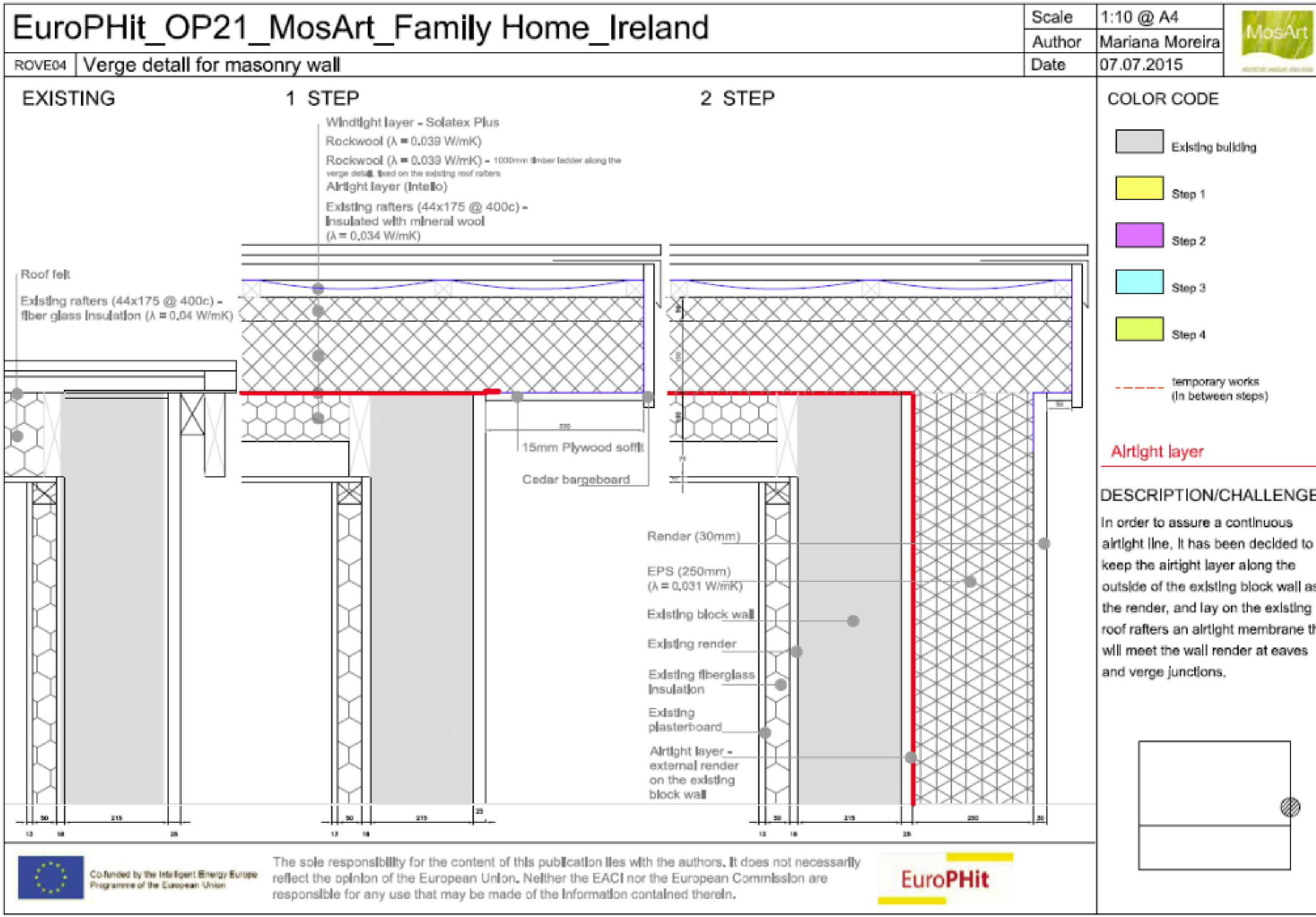
Examples

Steps in wall insulation

different facades



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Examples

Create a Service Zone Inside of Vapour Control Layer could also be very useful for future systems

Source: Empowerhouse, ns/Stevens Solar Decathlon 2011

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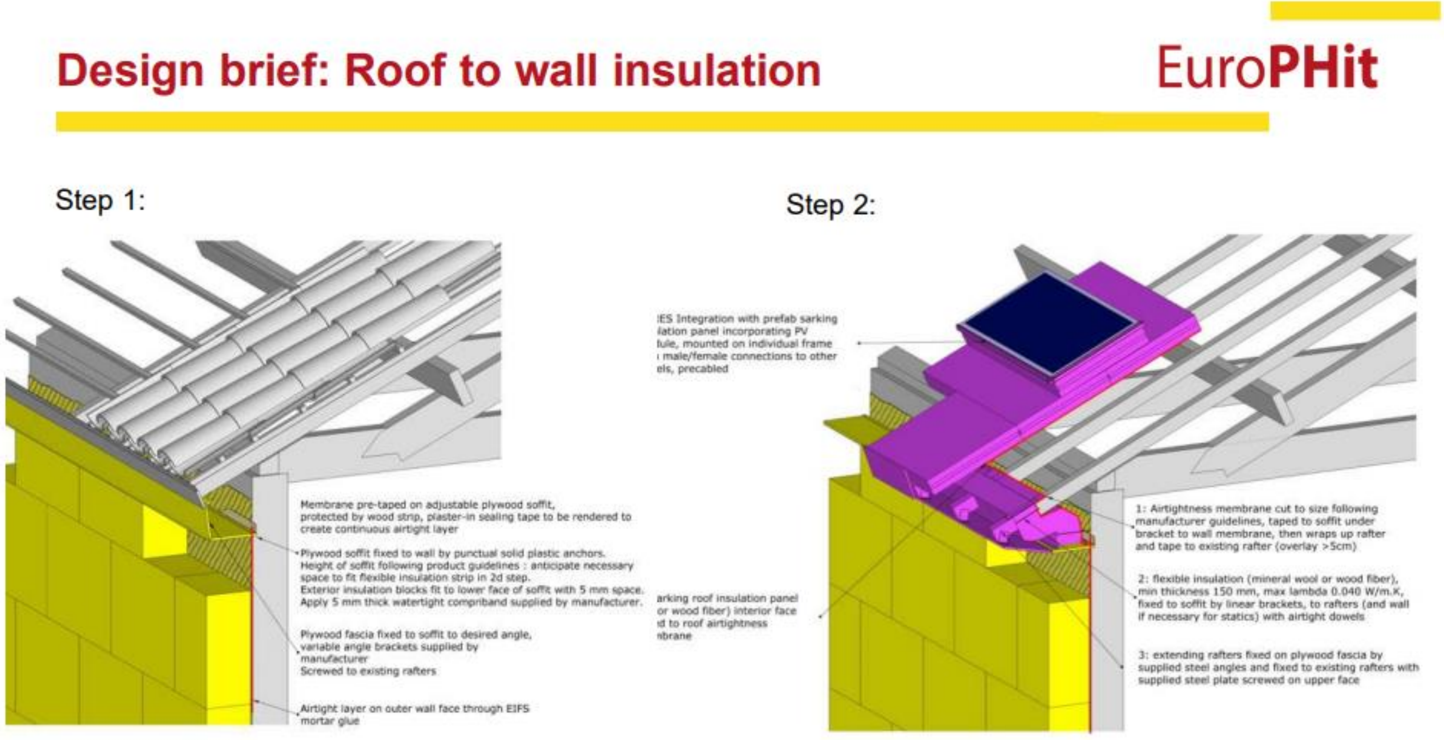
Examples

Plan the insulation overlapping before

implementing first steps



Roof to eave connection
(Source: LaMaison Passive)

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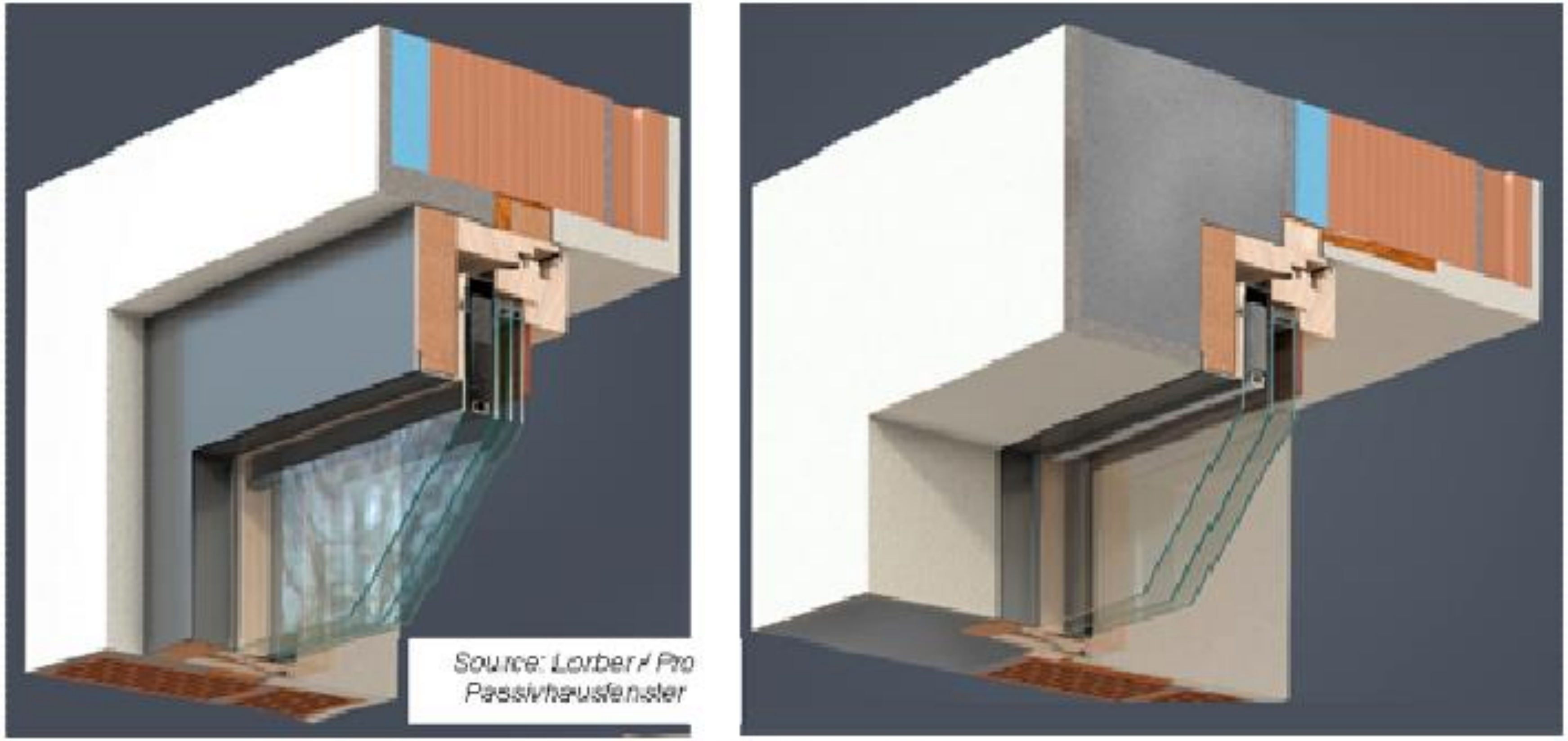
Examples

Innovations



The window is moved from the inside to the exterior during insulation

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