Permeable and ventilated roofs: an emerging solution for building comfort and climate mitigation in urban centers. The Project LIFE SUPERHERO

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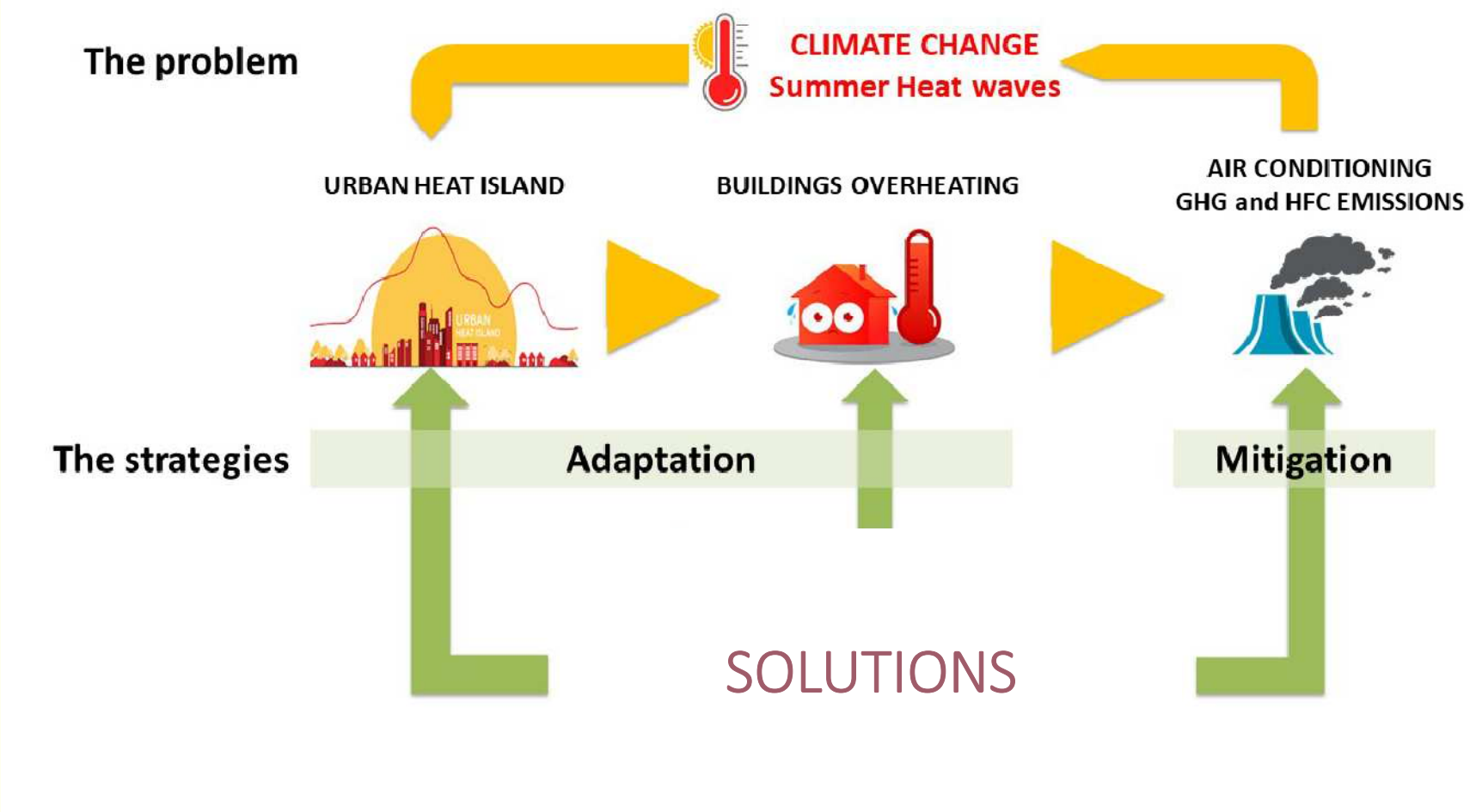
life SUPERHERO

SUstainability and PERformances for HEROTILE-based energy efficient roofs

THE PROBLEM TARGETED

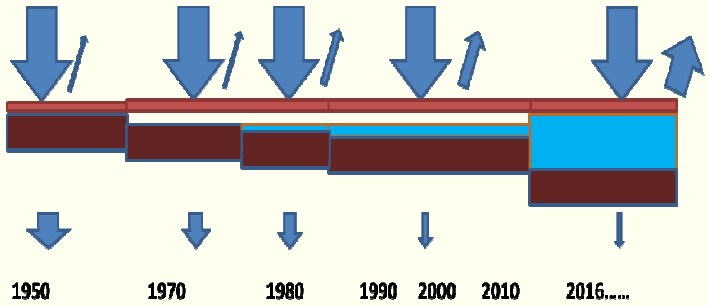


CONSOLIDATED APPROACH ON UHI REDUCTION: current solutions

Actual EU policies / BRS / BGPP

UHI

Building energy saving

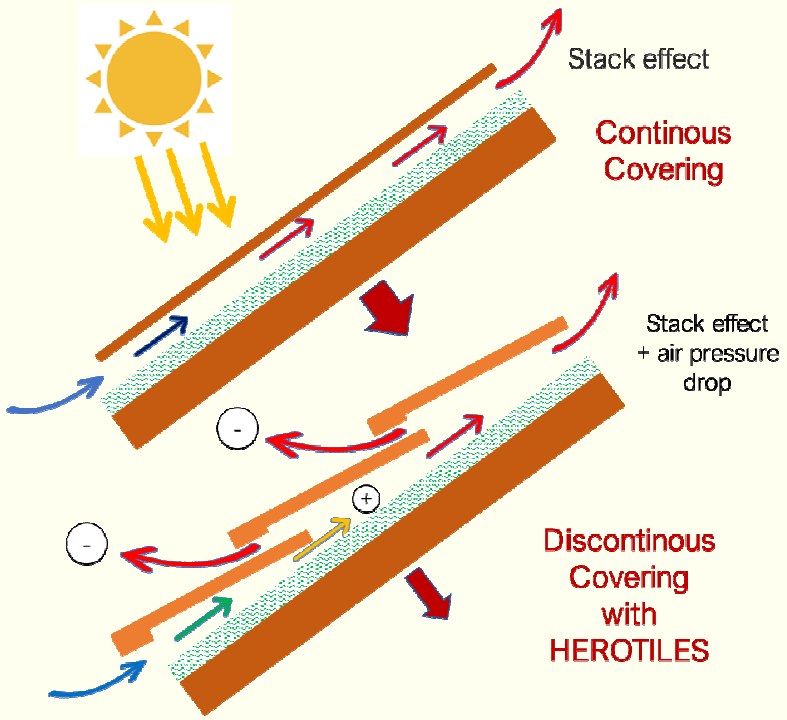


Impact of roofing technologies on UHI: current solutions

Regulation framework in Italy

	Strategy n.1	Strategy n.2
Italian building code DM 26 giugno 2015 "Requisiti Minimi"	Roof solar reflectance - 0,65 (flat roof) - 0,30 (tiled roof)	Passive cooling technologies (e.g.: ventilation, green roofs)
Italian Building GPP DM 11 ottobre 2017 CAM	Green Roofs	SRI greater than: -29 (slope > 15%) -76 (slope < 15%)
Building green rating system "Protocollo ITACA"	Green Roofs	SRI greater than: -29 (slope > 8,5°) -76 (slope < 8,5°)
Building green rating system "LEED"	SRI (after 3 years) greater than: -32 (slope > 15%) -64 (slope < 15%)	Green Roofs

THE SOLUTION PROPOSED



The use of Ventilated and Permeable Roofs (VPR) is the most sustainable and promising strategy to reduce building overheating. A vented roof can be obtained through an air space between installed roof covering and the roof sheathing. This space reduces heat transfer and allows heat to dissipate from the sheathing and roofing materials.

BACKGROUND

A previous project **LIFE HEROTILE** developed new types of roof tiles and demonstrated the effectiveness of the HEROTILES-based roof (**HBR**) in **reducing until 50% cooling energy** compared to other solutions.

However, general public, professionals and Building stakeholders, are not able to recognize the cooling potential of **ventilated permeable roofs** (**VPR**) and, thus, are not aware of the environmental and economic benefits of these new technologies (**VPR & HBR**).

THE CONSORTIUM

LIFE19 CCA/IT/001194

- TOTAL AMOUNT: 3,032,924 €

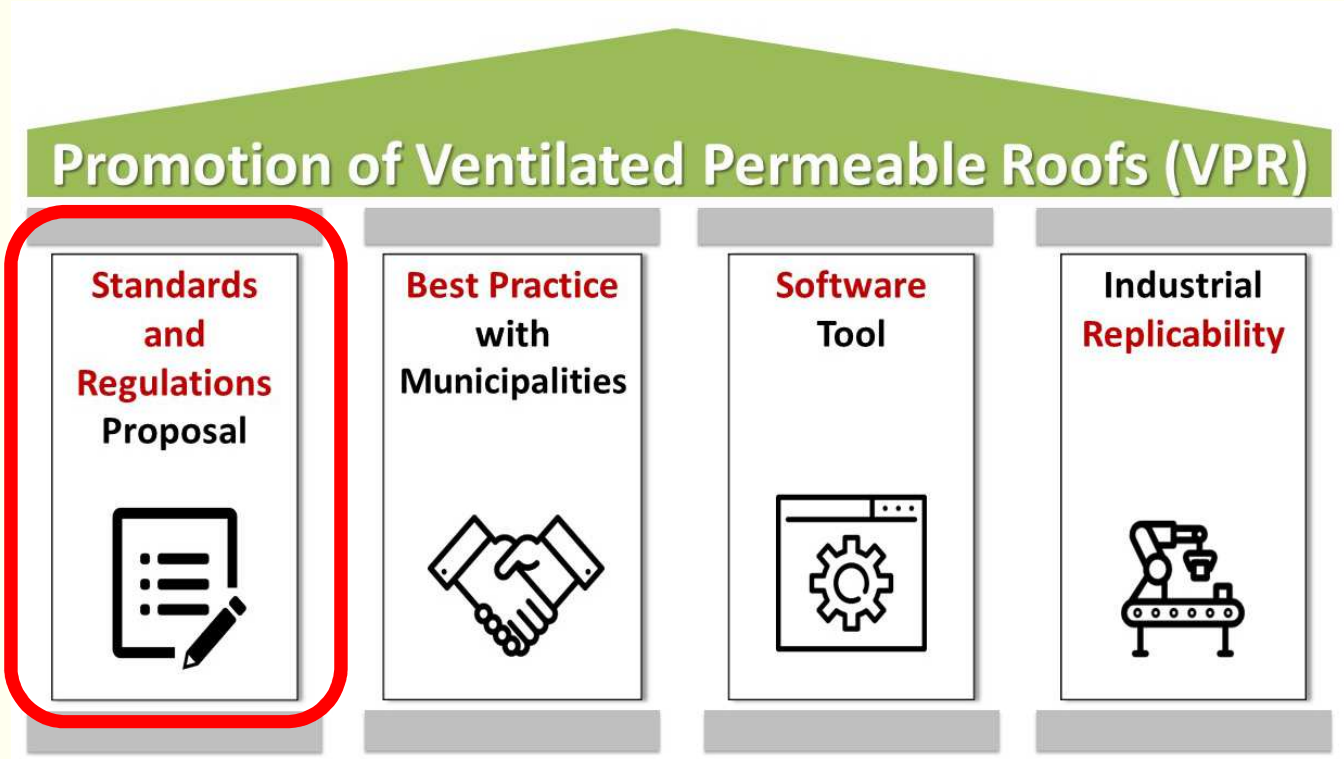
- EU CONTRIBUTION: 1,563,160 € (55%)

- 1/07/2020 - 30/06/2025

OBJECTIVES & SCOPE

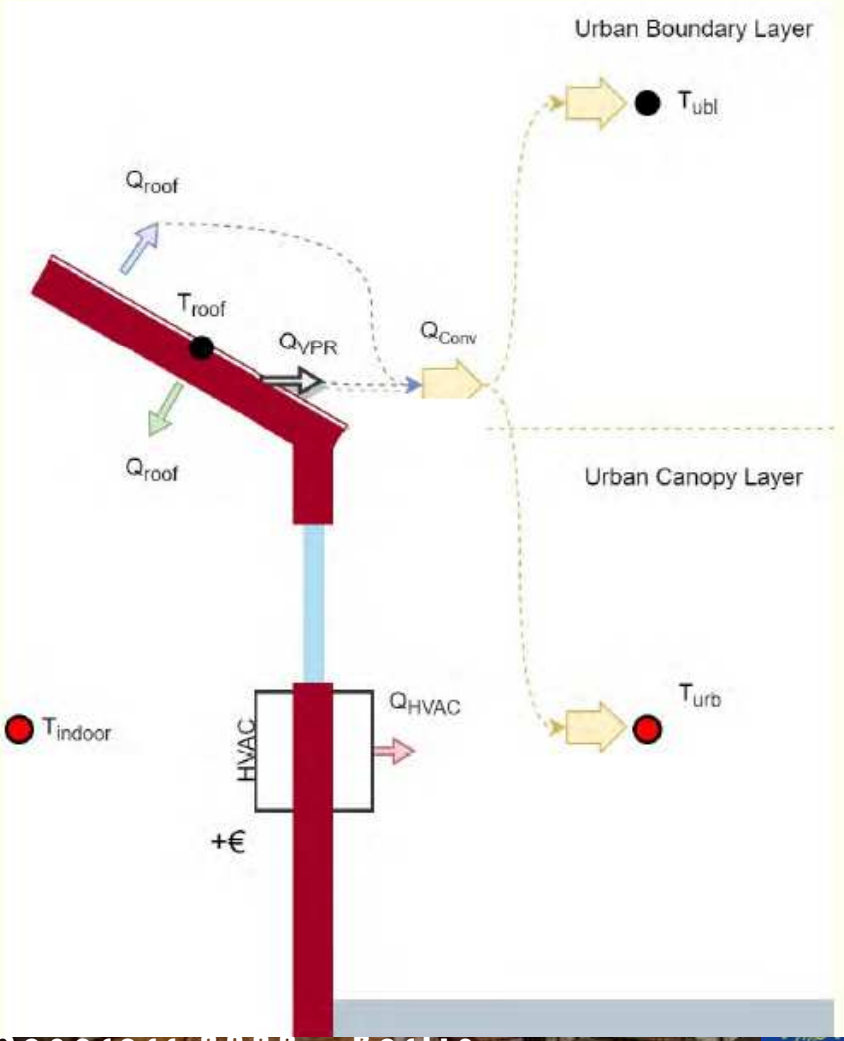
LIFE SUPERHERO is a **Best-Practice project**: it promotes the use of **ventilated permeable roofs** (VPR) as sustainable and cost-effective solutions for building "passive cooling", increasing building occupants' and cities summer comfort (**adaptation**) and decreasing buildings' energy and green-house gasses emissions (**mitigation).**

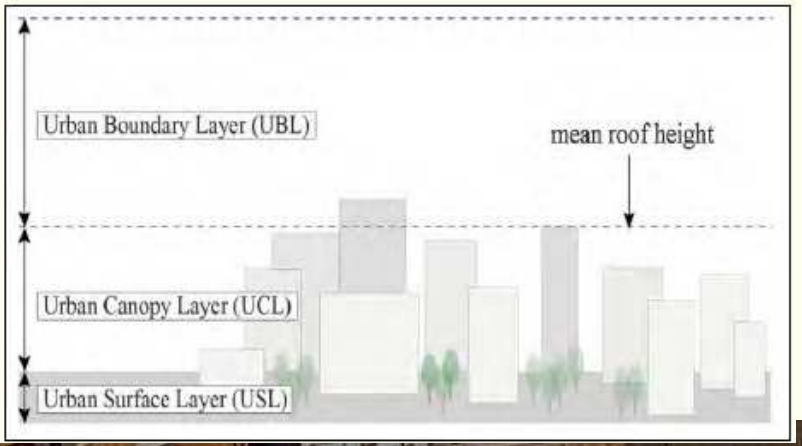
Based on a 4 pillars strategy!



Evaluation of VPR impact on urban climate

- Heat exchange with surrounding air
- Reduction of AC use and the related anthropogenic heat





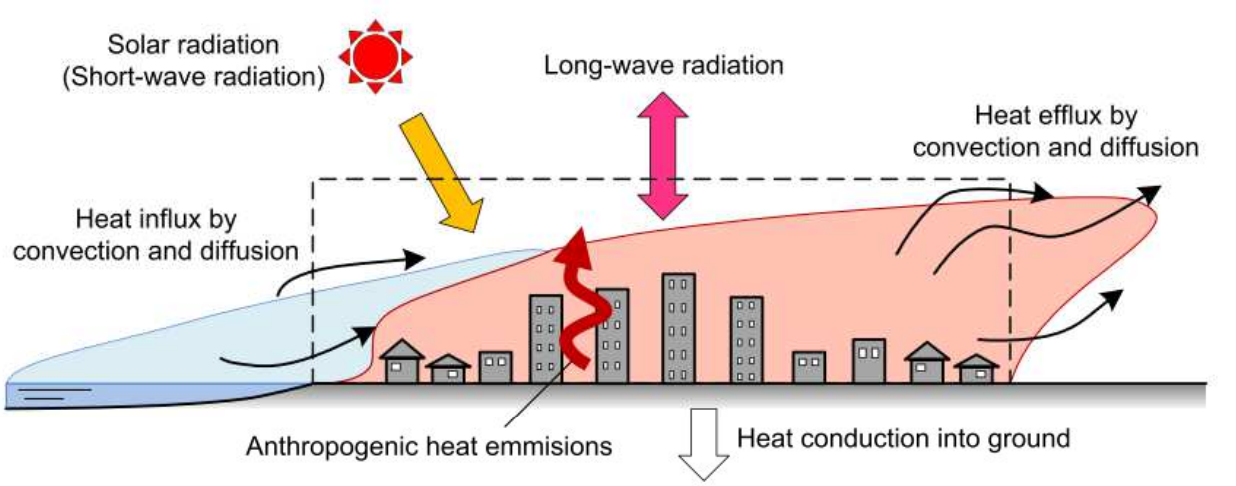
VPR impact on urban climate
Urban Weather Generator - UWG

- Open Source (the code can be modified)

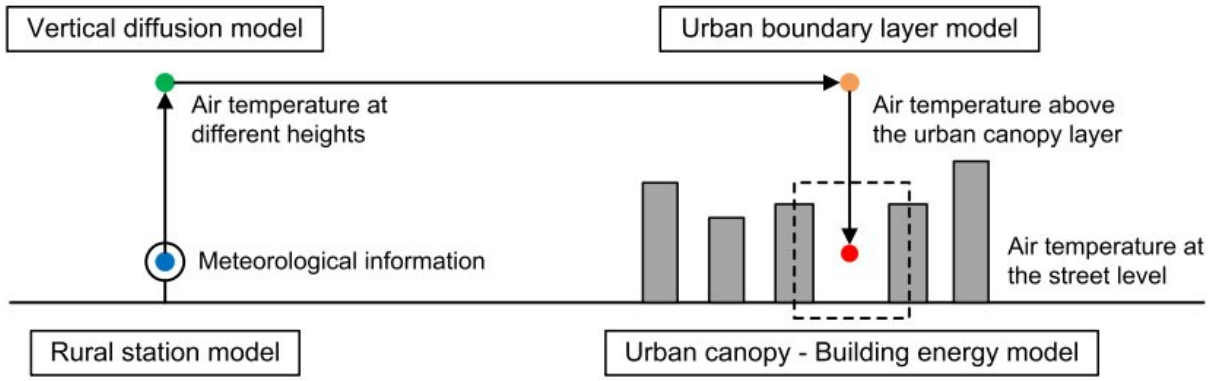
- Explicitly models the Urban Canyon features

- Good balance between accuracy and calculation speed

- Application and validation examples in the literature



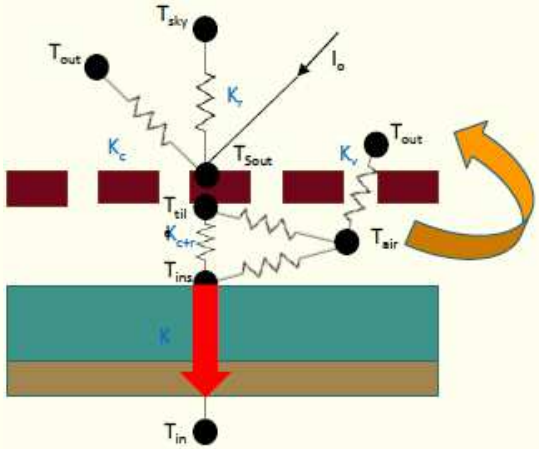
(a) The urban heat balance



(b) The urban weather generator

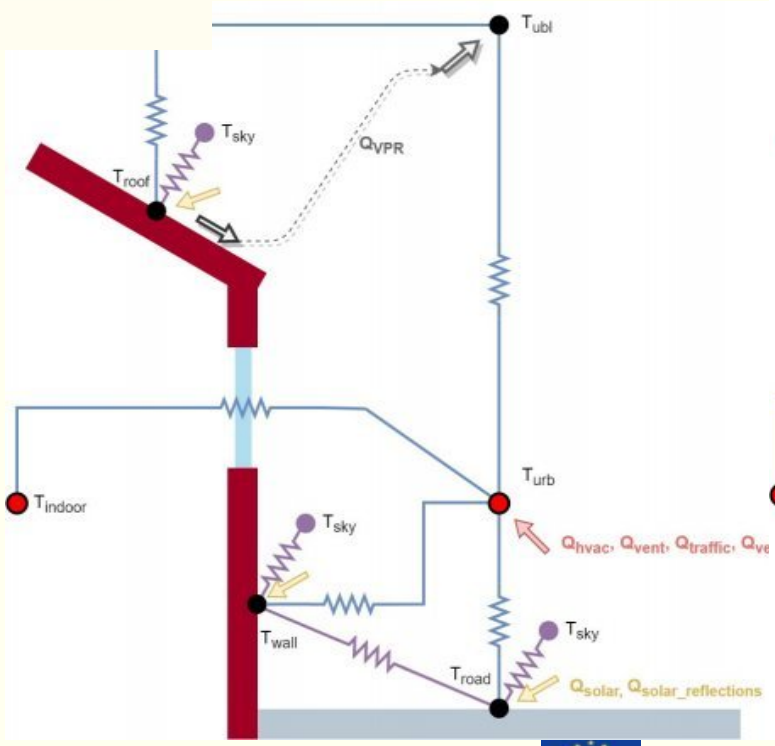
VPR impact on urban climate

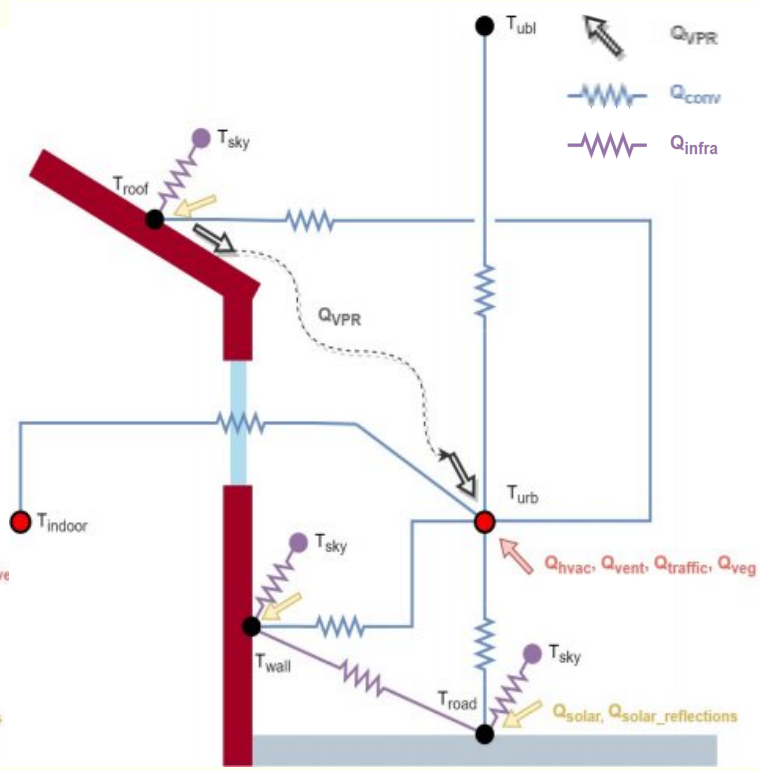
Heat exchange with urban boundary/canopy layer



Scenario A (most frequent)
Roof convection to UBL

Scenario B (less frequent)
Roof convection to UCL





VPR impact on urban climate

Roof typologies and urban morphologies

Roof typologies

- **Metal Roof** (**MR**, U=1.1 W/m²K, ρ = 0.25)
- **Cool Roof** (**CR,** U=1.1 W/m²K, ρ = 0.60)
- **Ventilated Permeable Roof** (**VPR**, U=1.1 W/m²K, ρ = 0.40)

Urban morphology (Reggio Emilia):

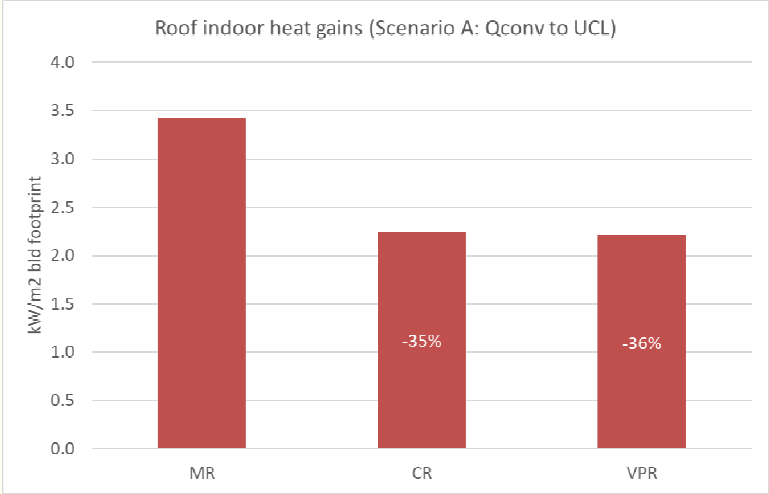
- Average building height = 10 m
- Building surface fraction = 67 %
- Canyon aspect ratio (H/W) = 1.52

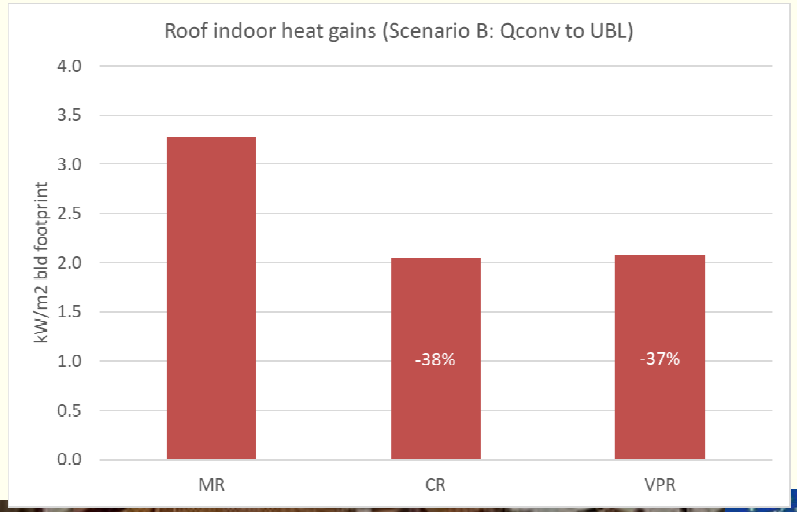
Building HVAC and use:

- CoP = 2.5
- Cooling setpoint = 24 °C
- HVAC activation = 24h/24
- Percentage of buildings using HVAC = 100%

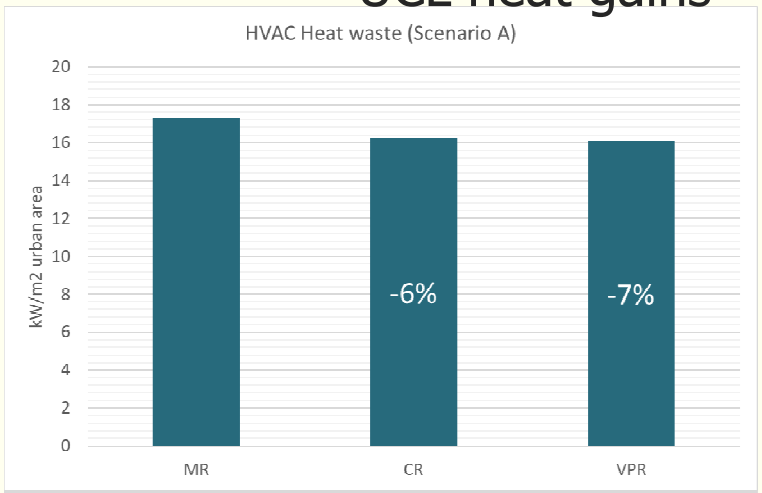
Evaluation of HBR impact on urban climate: preliminary results

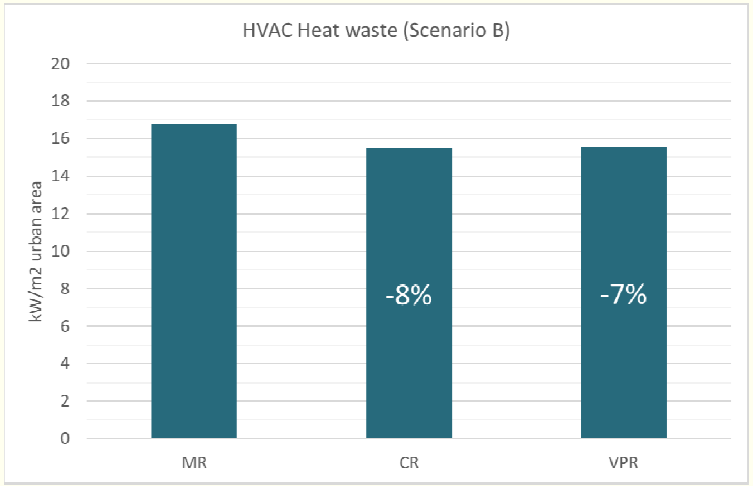
Internal Heat gains



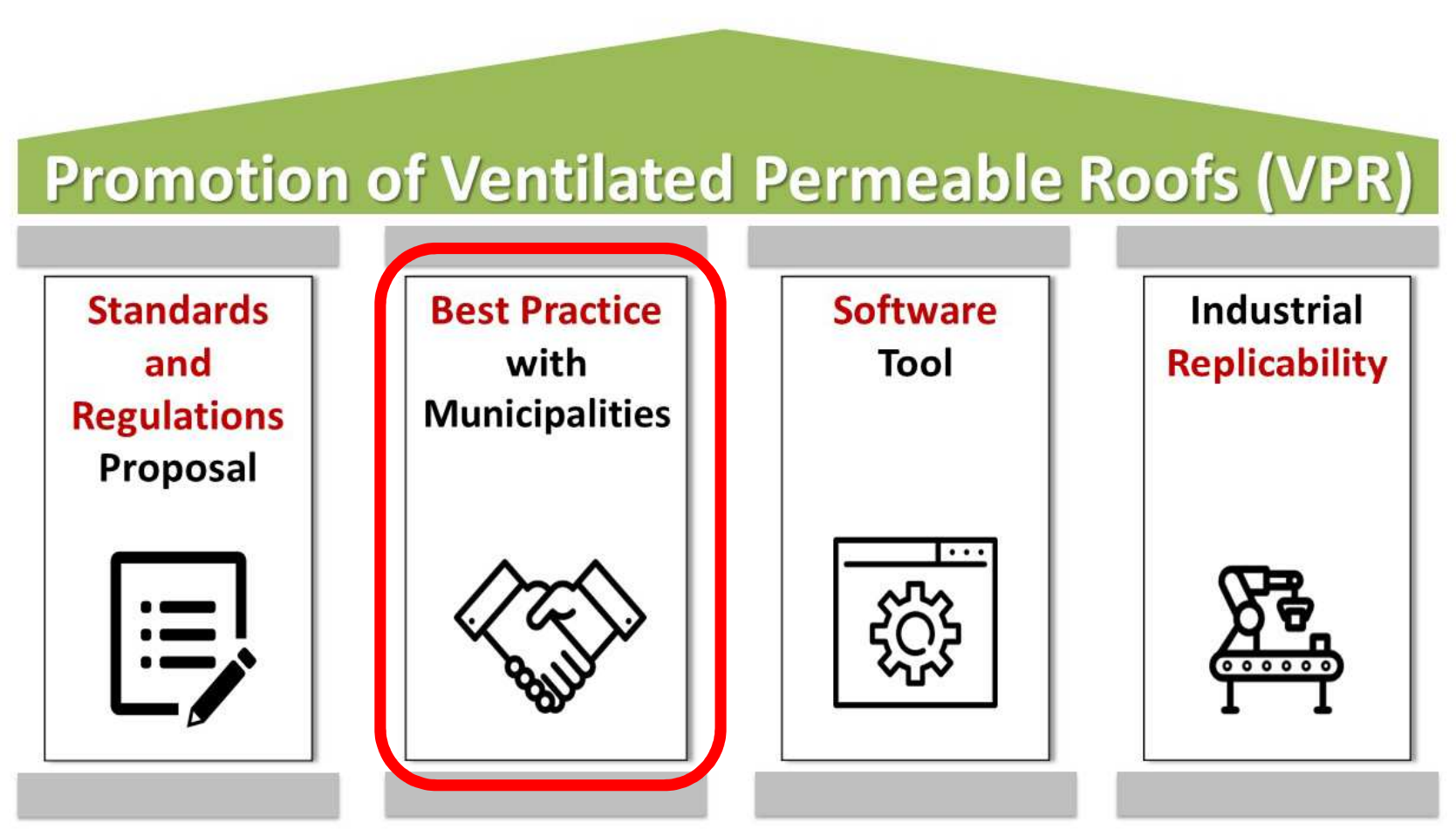


UCL heat gains





Promotion of VPR: main actions

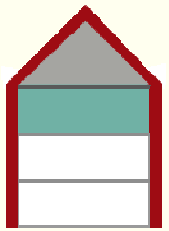


Best-practice for VPR-HBR
The demonstrator buildings

Best-practice for HBR: demonstrator renovation

Initial Renovation schedule

- The buildings identified for the LIFE SUPERHERO project will be renovated through regional funding POR-FESR 2019
  → We decided to adapt the monitoring activity.
- We have 4 empty flats in n. 23 (on a total of 5 flats of the last level) and 1 empty flat in n-25 (on a total of 5 flats of the last level)
  → Environmental data will be collected also in the empty flats to have a reference baseline and allow the energy models calibrations. We hope that the flats will be assigned in the future and we are ready to monitor them in that case.

2021/2022	2023	2024
Existing buildings	Renovated buildings	Buildings with new HBR
		

Best-practice for HBR: demonstrator renovation

Current Renovation schedule

- Issue on availability of construction materials & companies due to Bonus 110% - delay on the renovation schedule
- Extra summer monitoring (2022) on existing buildings and new measures on the roof without metal covering (to define the baseline)
- Monitoring on completed renovation on summer 2024

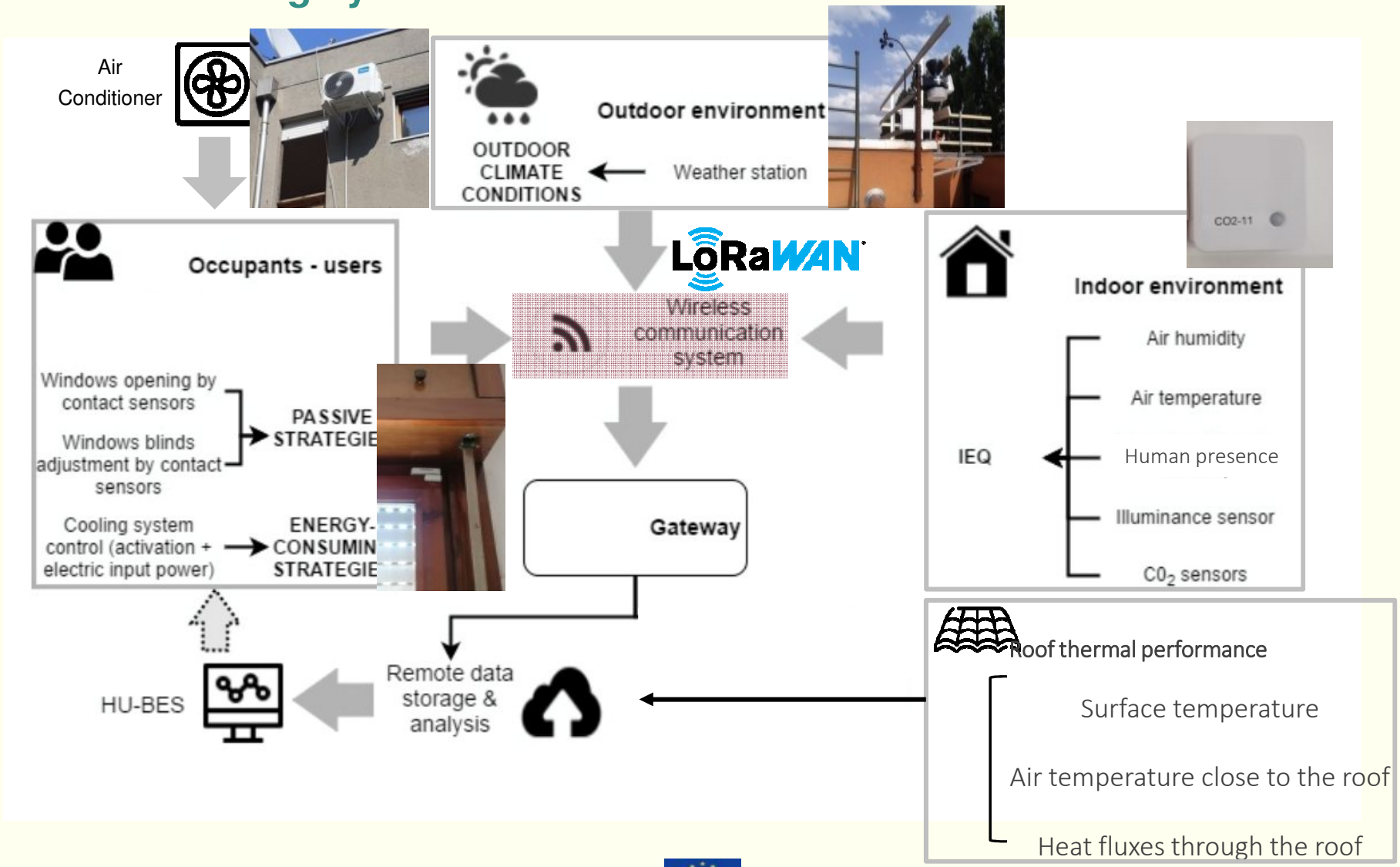
2021	2022	2023	2024
Existing buildings	Existing buildings	Renovated buildings	Buildings with new HBR

New Measures on the roof without metal covering

Construction of HBR from October 2023 to April 2024

Best-practice for HBR: The monitoring system

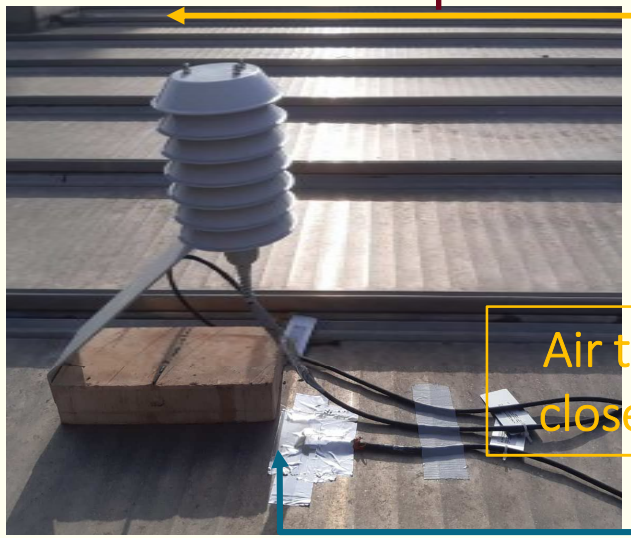
The monitoring system installation



Best-practice for HBR: The monitoring system

The monitoring system installation *(actual roof 2021)*

Surface/air temperature



Heat flux probe

Surface temperature

Air temperature close to the roof

Surface temperature

OUTDOOR

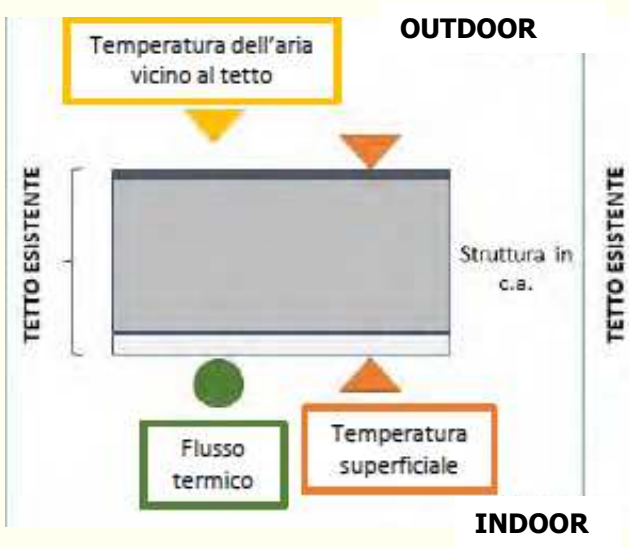
EXISTING ROOF
Slab of reinforced concrete

INDOOR

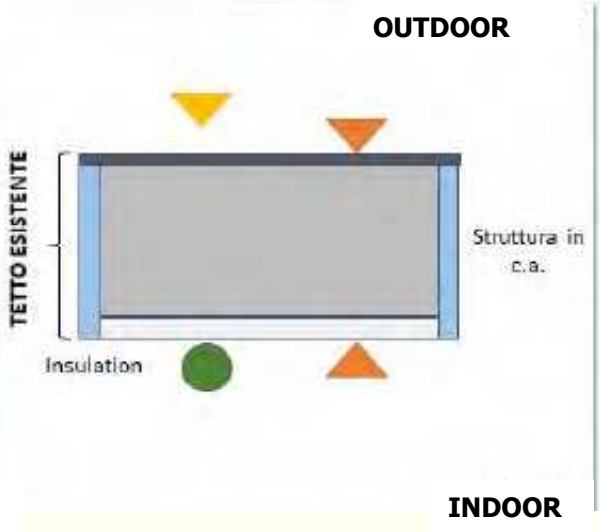
Heat flux through the roof

Surface temperature

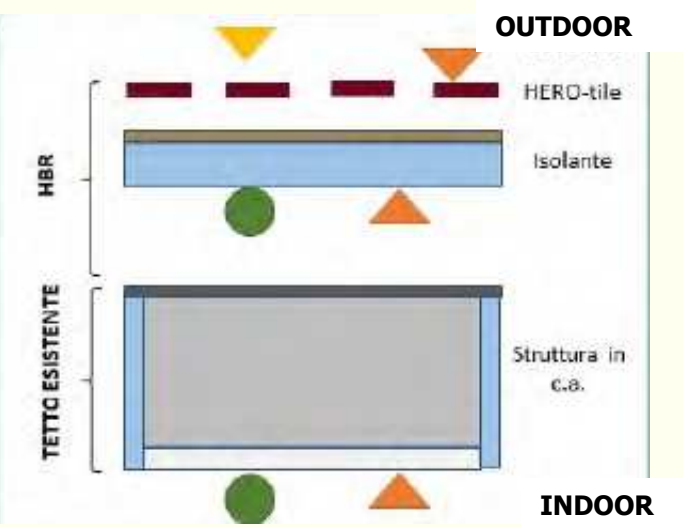
Best-practice for HBR: The monitoring system



Monitoring before renovation



Monitoring after vertical envelope renovation



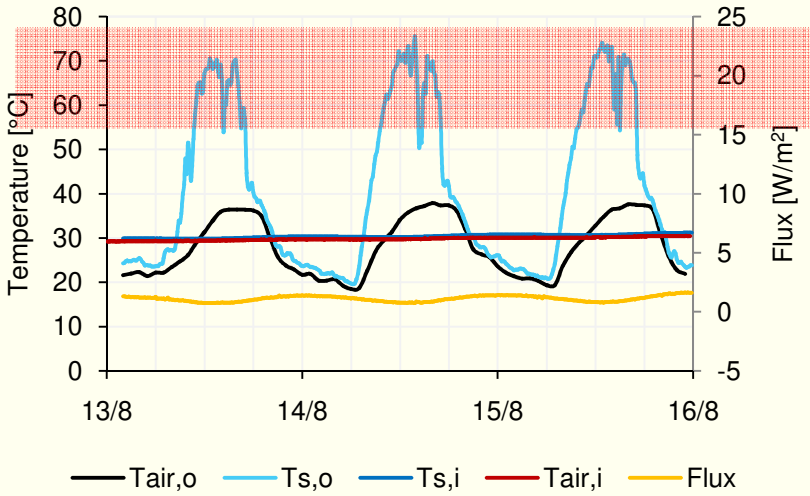
Final Monitoring of the building with VPR-HBR

Best-practice for HBR: Preliminary measurements results

The roof

Not occupied flat (#25 C)

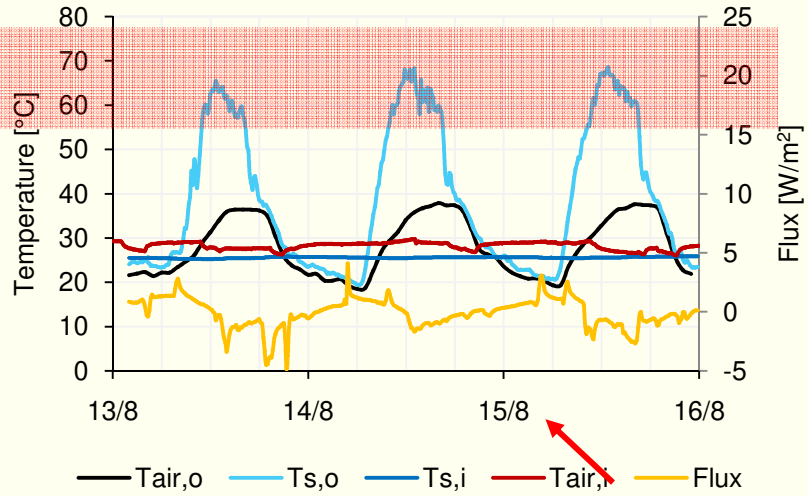
Closed west-facing windows, trees shielding, no conditioning system



- High outdoor surface temperature
- High thermal inertia
- Very low thermal heat fluxes
- Very high constant indoor air temperature (30°C)

Occupied flat (#25 B)

Est-facing windows, trees shielding

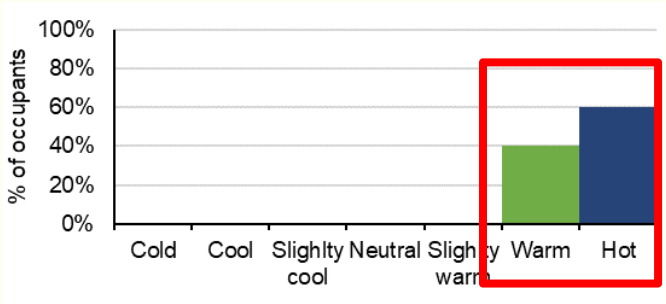


- High outdoor surface temperature
- High thermal inertia
- Very low thermal heat fluxes
- Irregular oscillation of the indoor air temperature (23 – 28°C) due to the AC system

Best-practice for HBR: The questionnaire

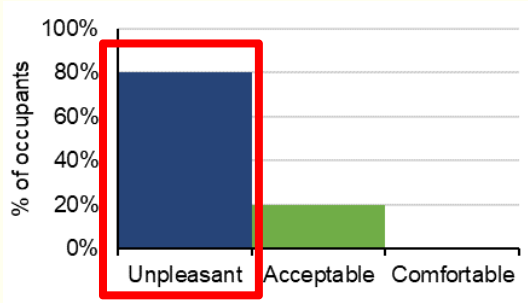
The occupants' survey

Thermal Sensation Vote



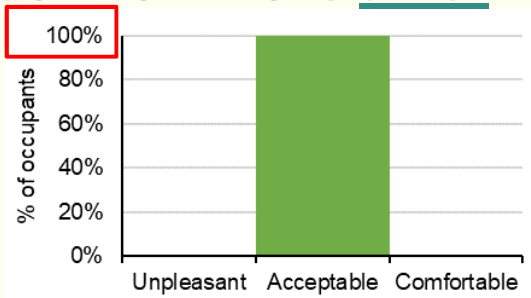
→ General thermal discomfort

Thermal Comfort Vote before the AC installation



→ Unpleasant thermal environment

Thermal Comfort Vote after the AC installation



→ Acceptable thermal environment

Benefits of clay tiles VPR

Among building passive cooling solutions, the use of **ventilated and permeable roofs** is an **efficient** and **sustainable** strategy:

- For the reduction of external roof covering temperature → UHI
- For the reduction of internal temperature and incoming heat fluxes → cooling energy

as demonstrated by LIFE HEROTILE

This is obtained trough **low cost , low maintenance durable and sustainable materials**

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With the contribution of the LIFE financial instrument of the European Community