lifeHEROTILE

*LIFE14CCA/IT/000939*

***High energy savings in building cooling by roof tiles shape optimization toward a better above sheathing ventilation***

# LAYMAN'S REPORT

***January 2019***

# Table of content

## LIFE Herotile

# LIFE Herotile

LIFE Herotile is co-financed by LIFE+, the financial instrument for the environment of the European Commission (LIFE14CCA/IT/000939)

## Goal

The aim of the LIFE Herotile project is to enhance the energy performance of buildings, through the development of two new roof tiles, with increased ventilation capabilities

## Duration

2015-2018

## Budget

2.5 Million Euro

## Project demonstration site

Italy, Spain, Israel

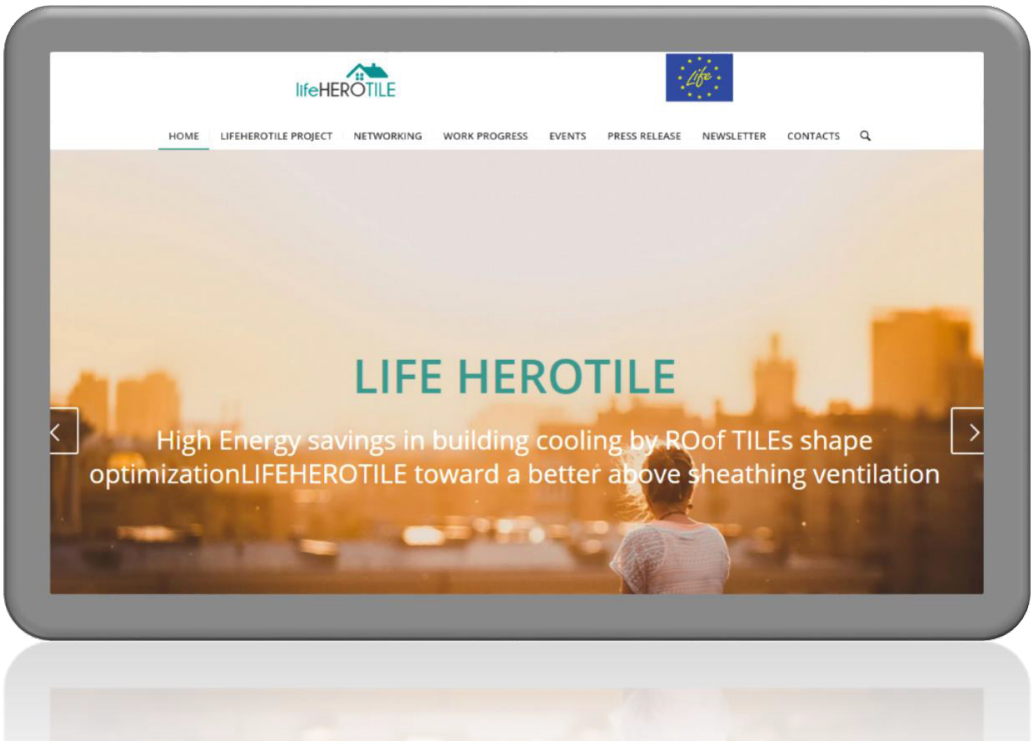
## Partners

ACER-Reggio Emilia (IT), ANDIL (IT), Industrie Cotto Possagno* (IT), Monier Technical Centre (D), Monier Redland (UK), Terreal (F) and University of Ferrara (IT)

* Project coordinator

## Project website and social media

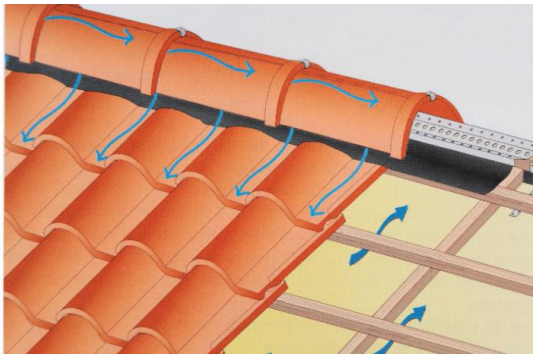
www.lifeherotile.eu | twitter.com/LifeHerotile | facebook.com/lifeherotile



# 1. Summary of project scope and objectives

## *1.1 Project scope*

In the Mediterranean area, summer radiation can lead to the overheating of building coverings (roofs and walls). Thus, air-conditioning becomes more and more essential.

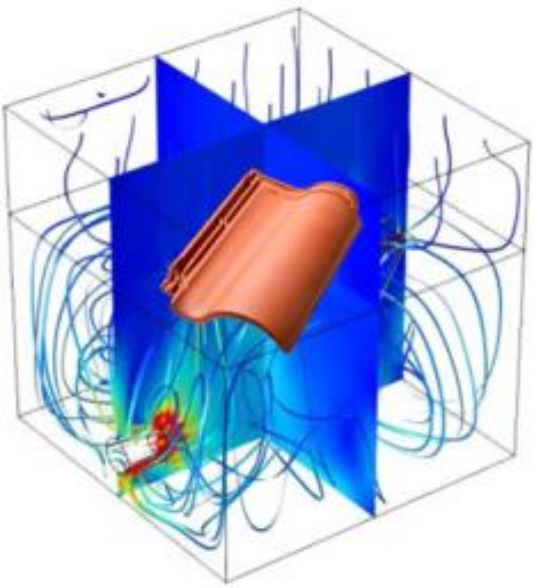


A ventilated roof is one solution for reducing solar infiltration through the tiles, because the air movement removes some of the heat caused by solar radiation. This effect could be enhanced by increasing the flow of air through tiles; modifying the shape of the tiles, whilst preserving the original appearance.

LIFE Herotile aims to improve the energy behavior of buildings through the development of innovative types of roof tile able to increase the ventilation between and below the tile array.

Due to technologies and systems suitable for the purposes of being replicated, transferred or applied sustainably, the project will contribute to the development and implementation of energy saving approaches, mainly in the Mediterranean region, and to climate change mitigation.

## *1.2 Objectives*



The project is compliant with the European energy policies involving low-carbon technologies because it allows energy savings in air conditioning, which represents 40% of overall energy demand.

The proposed project aims to control and reduce the energy requirement for cooling, specifically the major energy demand in air-conditioning. This demand is not yet regulated by law in several European countries, most of them in Southern Europe where it is most relevant. Additionally pitched roofs are widespread across the whole of the Mediterranean region.

Assuming a pitched roof replacement rate of 4.3% per year of roofs of the oldest buildings in Central Southern Europe – consistent with realistic production rates of new tiles – a net saving of 79.2 $MtCO_2$ should be obtained during the typical 50 year lifespan of a roof. That means that the annual reduction value of $CO_2$ emissions would be 1.58 $MtCO_2$/year.

**In fact, according to the results of the Life Herotile Project, the new tile designs are able to save up to 50% of the energy use in cooling mode.**

# 2. Description of the techniques/methodology implemented and results achieved

## *2.1 Project activities*

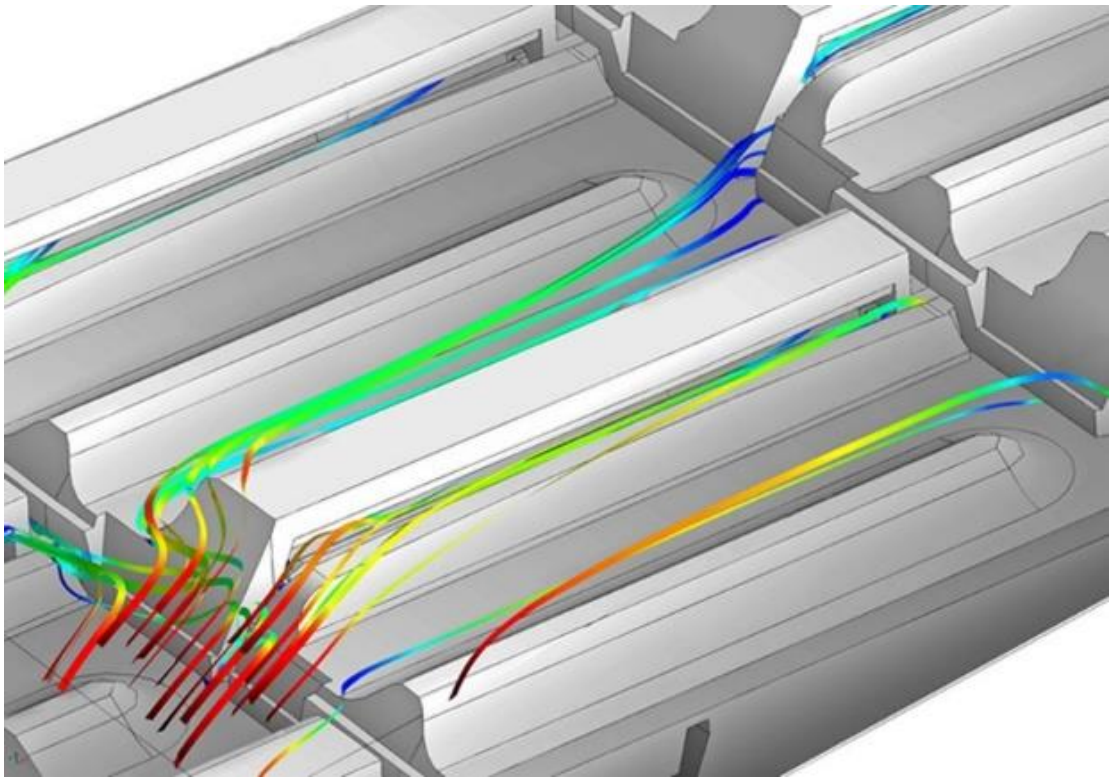
In order to help the EU construction sector (refurbishment and new constructions) to achieve its energy efficiency and related CO2 emissions targets and to facilitate the global market uptake of an eco-innovative EU product able to help reaching these objectives, the LIFE HEROTILE project developed:

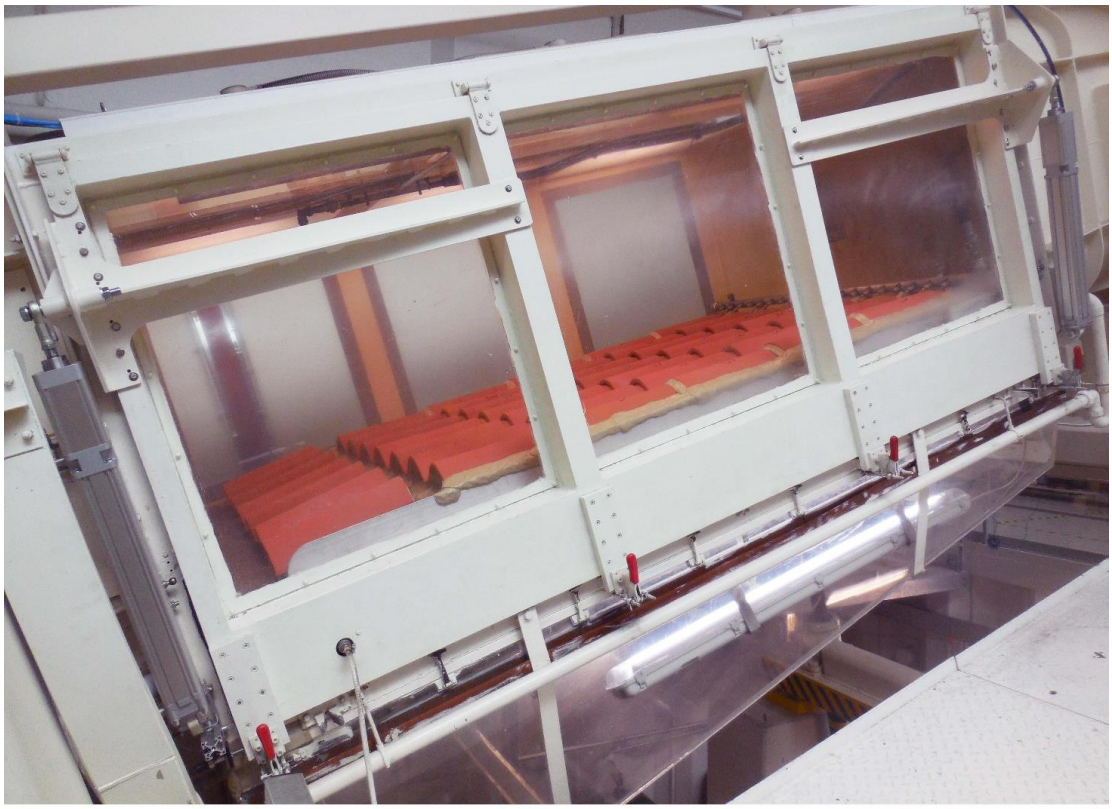
**TWO NEW TYPES OF ROOF TILE (PORTUGUESE AND MARSEILLAISE TILES)**

with a shape characterized by a higher air permeability through the overlap of the tiles, providing a better energy performance by passive disposal of the solar radiation through under-tile ventilation.

The new tiles were designed using a calibrated 3-dimensional CFD model tested under a range of conditions. The CFD model was used to understand how much the roofing tile design could affect the air permeability.

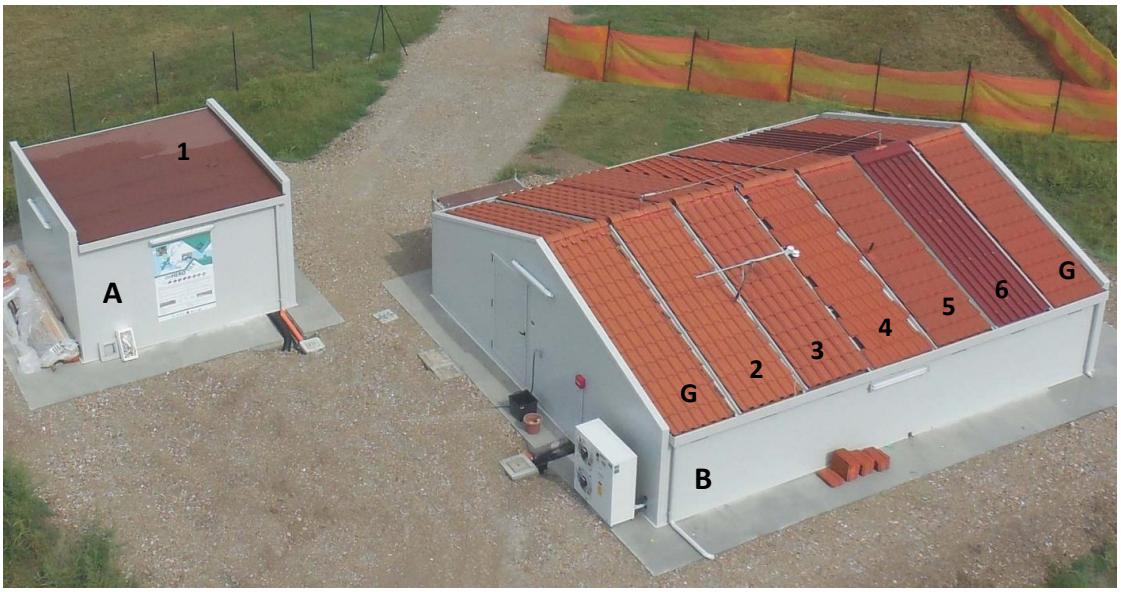
The simulations modelled conditions for different wind directions and intensities. They provided the data necessary to develop a new type of tile, capable of increasing the air flow through and below the tile array, ideally without allowing significant levels of water ingress. Prototypes of the new tiles were also tested in a wind tunnel to compare their driving rain performance to existing tiles.





## TWO REAL-SCALE TEST BUILDINGS

with six different roofs were used to measure the new tile performance in two different locations (Yerucham, Israel and Ferrara, Italy), comparing the summer energy performance of the new tile designs with existing traditional tiles and also with different types of roof covering surfaces.





*Building A: flat roof (1), located on a separate building*

*Building B: guard chamber (G); traditional Portuguese tiles (2); Portuguese HEROtiles (3); Marseillaise HEROtiles (4); traditional Marseillaise tiles (5); metal (6); guard chamber (G)*

## TWO DEMONSTRATOR BUILDINGS

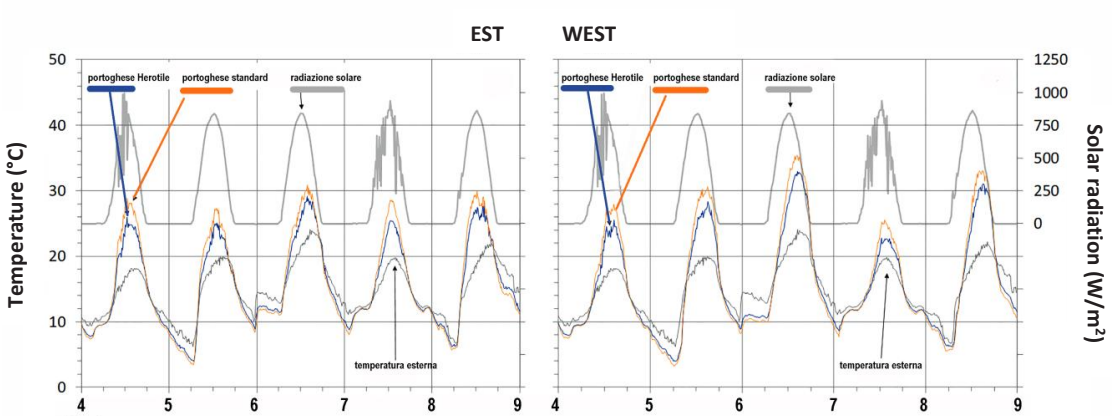
from social housing located in the Mediterranean region (Cadelbosco, IT and Zaragoza, E) were chosen to measure and quantify the benefits of the new tiles.

On the left, the new roof with Portuguese Herotiles; on the right, the original roof of the building in Cadelbosco with traditional Portuguese tiles

## A PRACTICAL AND SIMPLE UNLICENSED SOFTWARE

**developed for architects and technicians – SENSAPIRO (Software ENergy SAvings PItched Roofs)**, allowing them to compare the change in energy performance of a building with different roof configurations.

Measurements of the new tiles under real life conditions and at real scale were used to validate the software predictions for the assessment of energy savings of a pitched tile roof with the new HEROtiles.




March 2017

## 2.2 Obtained results

The outcomes of the LIFE Herotile project are:

**THE NEW MARSEILLAISE AND PORTUGUESE TILES**

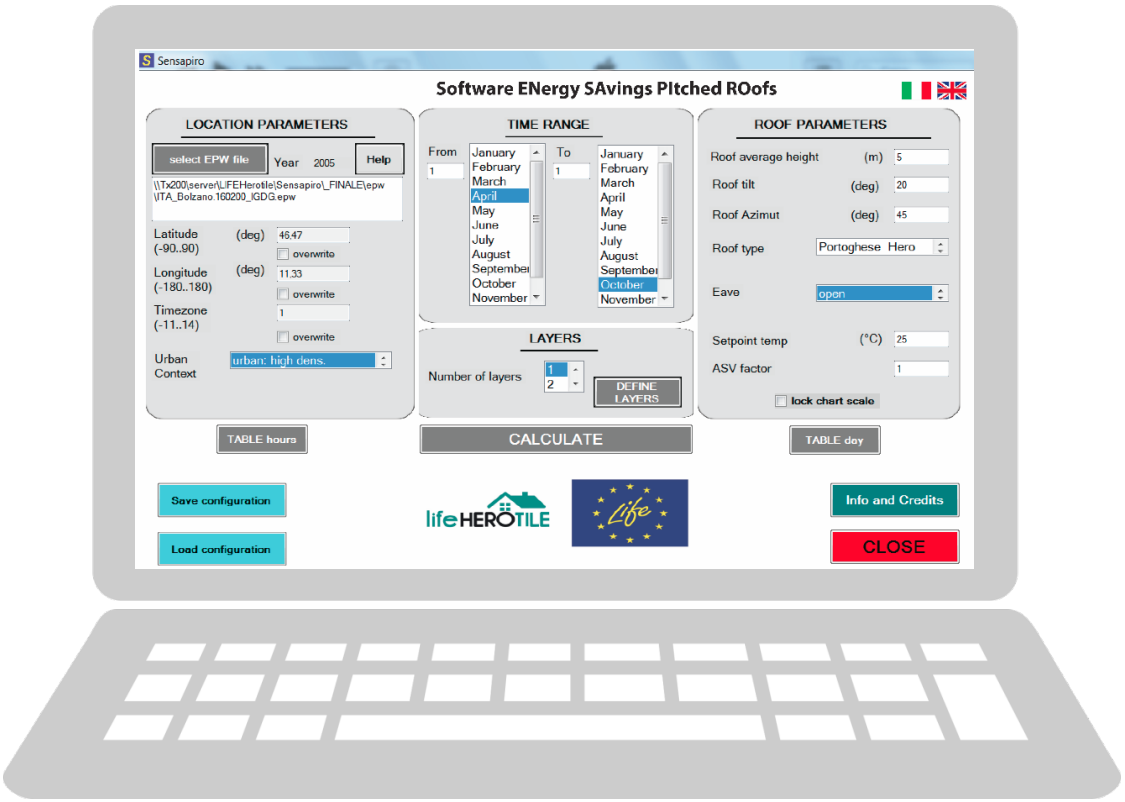
characterized by a higher air permeability, which are able to halve the energy requirement for space cooling from an average value of 15 kWht/m$^2$.

*Portuguese Herotile*

*Marseillaise Herotile*

**SENSAPIRO UNLICENSED SOFTWARE**

a simple tool to compare the energy performance of a building with different roof configurations.



# 3. Assessment of the benefit and impact

## 3.1 Heat gain for different types of roof and locations

The SENSAPIRO software predicts the solar heat gain that will increase the temperature of the living space below the roof and allows the user to compare the behavior of different roof types (flat roof or a pitched roof covered with metal, traditional Portuguese and Marseillaise roof tiles, new Portuguese and Marseillaise Herotiles).

| SENSAPIRO | Existing roofs | | | Replaced by HEROTile | HEROTile vs | | |
|---|---|---|---|---|---|---|---|
| | 20° roof pitch | | Flat | | | | |
| | Roof tile* | Metal | | | Roof tile* | Metal | Flat |
| *Locations* | *heat gain kWht/m²* | | | | *% heat gain reduction* | | |
| **Tel Aviv** | 13.1 | 20.4 | 35.2 | 9.7 | -26.2% | -52.6% | -72.6% |
| **Bucarest** | 11.1 | 16.6 | 26.2 | 8.1 | -27.5% | -51.3% | -69.2% |
| **Atene** | 14.2 | 21.4 | 34.8 | 10.2 | -28.5% | -52.6% | -70.8% |
| **Sofia** | 7.6 | 11.7 | 18.2 | 5.3 | -30.0% | -54.5% | -70.8% |
| **Madrid** | 8.8 | 15.9 | 21.2 | 5.7 | -35.4% | -64.0% | -73.1% |
| **Belgrado** | 10.2 | 15.4 | 24.3 | 6.6 | -35.6% | -57.4% | -73.1% |
| **Roma** | 10.8 | 15.8 | 25.1 | 6.6 | -38.5% | -58.0% | -73.6% |
| **Monaco** | 7.4 | 11.6 | 18.1 | 4.5 | -39.0% | -61.0% | -75.1% |
| **Francoforte** | 7.0 | 10.9 | 17.2 | 3.9 | -45.0% | -64.6% | -77.5% |
| **Parigi** | 6.9 | 11.0 | 16.9 | 3.7 | -46.6% | -66.5% | -78.3% |
| **Bruxelles** | 6.1 | 9.4 | 15.2 | 3.2 | -48.3% | -66.2% | -79.2% |
| **Vienna** | 7.6 | 12.0 | 18.7 | 2.7 | -65.2% | -77.7% | -85.8% |
| *Average values* | ***15.4*** | | | ***5.8*** | ***-38.8%*** | ***-60.5%*** | ***-74.9%*** |
| | | | | | ***-58.1%*** | | |

** Portuguese traditional tile*

*SENSAPIRO input data:*

- Period: **1st May – 30th September**
- Roof composed of 5 layers:

| Layer | Thickness [mm] | Thermal conductivity [W/mK] | Density [kg/m³] | Specific heat [J/kgK] |
|---|---|---|---|---|
| **Plaster** | 20 | 0.54 | 1500 | 1000 |
| **Hollow flooring block** | 200 | 0.35 | 750 | 840 |
| **Low reinforced concrete** | 40 | 1.6 | 2300 | 1000 |
| **Linoleum** | 1 | 0.17 | 1200 | 1400 |
| **XPS** | 60 | 0.036 | 30 | 1200 |

- Setpoint internal temperature: 25 °C

**The above table shows an average reduction in heat gain of 58.1% by substituting the existing roofs with the new HEROtile. This agrees with the project forecast of a 50% reduction in the energy requirement for space cooling from an average value of 15 kWht/m².**

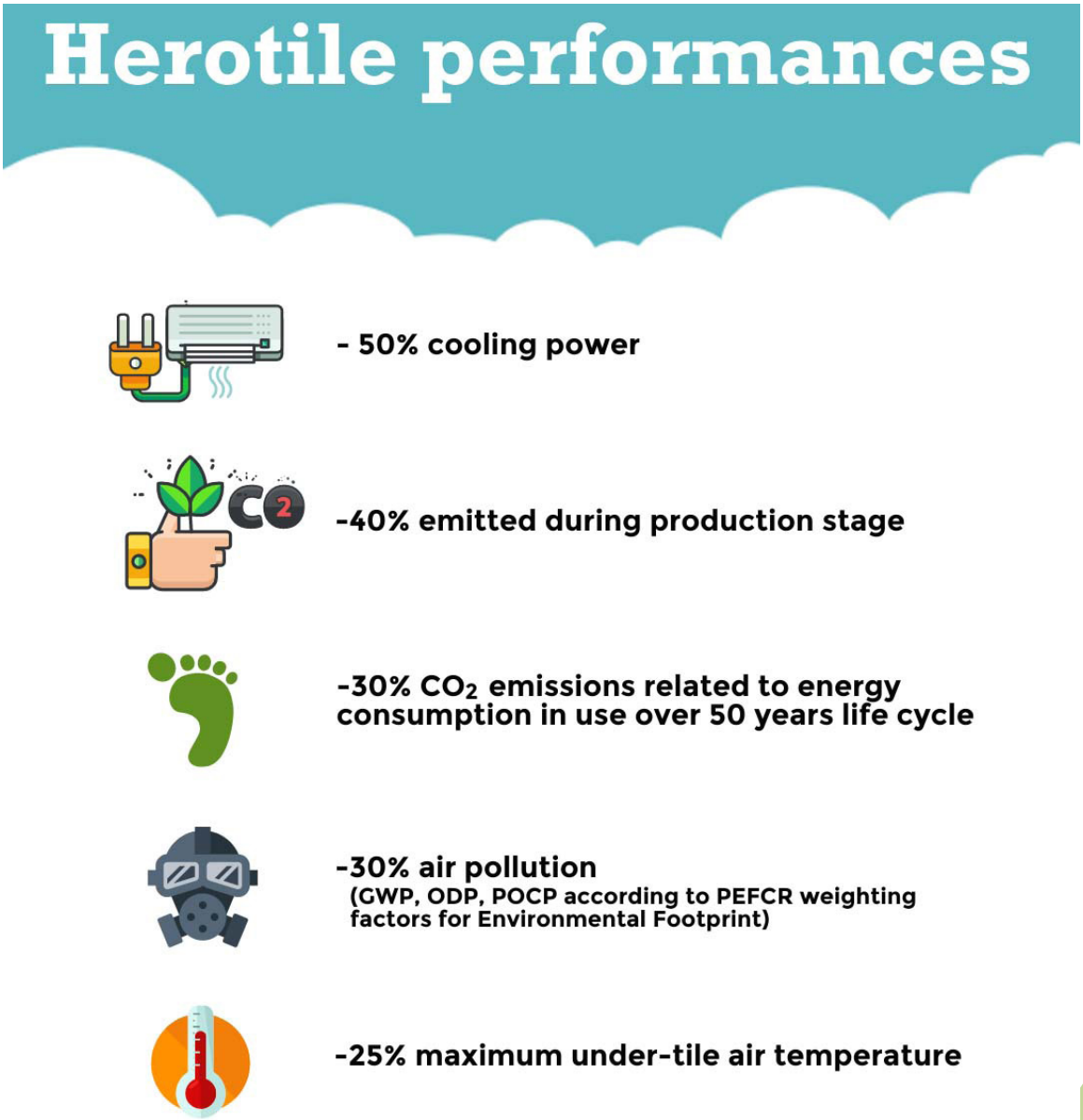
## 3.2 Environmental impact

According to the predicted outcomes of the Life Herotile project, the new tile designs are able to save up to 50% of energy use in cooling mode, based on an average value of the cooling energy requirement being 15 kWht/$m^2$.

Based on a realistic scenario of replacing roofs of the oldest buildings in Central Southern Europe by refurbishing 53% of the total roofs in 12 years, a replacement rate of 4.3% per year is required. The required output of roof tiles to achieve that rate is consistent with the production of the new tiles.

Therefore, a net saving of 79.2 $MtCO_2$ should be obtained during the typical 50 year lifespan of a new roof; equivalent to an annual reduction in $CO_2$ emissions of 1.5 $MtCO_2$/year.

The Life Cycle Assessment (LCA) of HEROTILE roof, based on EN15804, has shown a -30% reduction of Life Cycle $CO_2$-eq. emissions compared to a traditional clay roof tile over a 50year life cycle.



# 4. Transferability of results

LIFE HEROTILE has demonstrated that if Above Sheathing Ventilation (ASV) is combined with a high "air permeability" of the roof tiles it is possible to obtain a considerable improvement in the roof cooling performance (limiting the incoming heat fluxes in the summer months due to the high solar irradiance). Furthermore, this performance is obtained in a sustainable manner when durable and sustainable materials such as clay tiles are used, as it does not require the use of additional materials and technologies.

**Finally, vented tiled roofs can be considered one of the best solutions for passive building cooling in hot and mild climates.**

Even if LIFE HEROTILE has shown a sound technological adaption of tiles to make the roof even more effective as a sustainable "passive cooling" technology, there are several barriers to overcome in order to properly promote and disseminate the "HEROTILE-based roof" (HBR) technology in Europe and beyond; spreading the concept that passive cooling solutions for buildings can deliver an improvement in thermal comfort and energy savings with low environmental impacts and costs, thus providing a robust contribution to climate change mitigation and adaptation.

Considering the increasing building cooling needs, and heightened effects of climate change, the HEROTILE industrial partners are proposing a new research project as a continuation of LIFE HEROTILE, to provide effective support for its dissemination through specific policies/legislative frameworks and tasks to increase public awareness of its potential.

The new project will aim to promote the use of HBR as sustainable passive cooling technology by:

- overcoming the existing policies/legislative barriers;
- demonstrating the impact of HBR use on occupants' "green" behaviours;
- providing a tool to assess HBR environmental and economic benefits.