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# The Wall-ACE project: an overview of the in-field monitoring on the novel Aerogel-based products.

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**ABSTRACT**
The increasing demand for high energy efficient buildings has lead to a growing interest in building envelope solutions characterised by an high level of innovation. The necessity of providing new solutions for the energy retrofit of existing and – especially – old and/or listed buildings is rising great challenges. A promising perspective comes from the implementation of aerogel-based Super Insulating Materials, which can provide added value with respect to current envelope technologies.
In this framework, the EU H2020 research project Wall-ACE aimed at developing a suite of Aerogel-based sustainable insulation solutions for the building market. The five insulation products under development were specifically designed for both the renovation of existing buildings and for the construction of new zero energy buildings. The aim is to achieve for each product a thermal conductivity significantly lower with respect to the state-of-the-art solutions. In this paper, an overview of the research activities which led to the development of these new high insulating products is presented. The products developed were tested through laboratory tests, numerical analysis, small scale and full-scale experimental activities. In this paper, the different large-scale test facilities and the case study buildings selected in different EU countries (Italy, United Kingdom and France) to test the different products developed are showed.

KEYWORDS
Aerogel, thermal insulation, retrofit, plaster, rendering.

## INTRODUCTION
The energy saving potential that can be achieved through the building energy retrofit is widely known since about the 80% of the existent stock was built when poor energy saving criteria were in force. To reduce the energy demands related to buildings and to comply with the European target for 2030, innovative insulating materials for the energy retrofit of buildings are needed. The solutions to be developed should carefully consider the number of issues that could be faced during the energy refurbishment, i.e. the use of internal space, historical and technological constraints. So, it is of paramount importance to develop new materials and solutions characterised by very high thermal insulating performance.
The development of aerogel-based super-insulating materials and solutions suitable for new buildings and the energy renovation of existing ones is the aim of the European Horizon 2020 project Wall-ACE. The proposed solutions involve an internal insulating plaster, an internal coating finishing, an external insulating render, an insulating patching filler and aerogel filled bricks; all the solutions developed in the framework of the project are based on the Kwark® aerogel produced by Enersens. The internal plaster and the external render are developed

respectively by Vimark and Quick Mix; these products are suitable for the reduction of the heat losses through the envelope by the application of a few centimetre thick layers. The thermal coating finish, also developed by Vimark, is a product that can be applied in a few millimetres aimed at mitigating the thermal bridge and reduce the mould growth risk. The insulating interior patching filler is developed by Toupret to patch holes, fill cracks and to mitigate the punctual thermal bridges in building elements. Finally, the filled bricks produced by Leipfinger Bader were developed with an optimised geometry to be filled with a high-performance aerogel charged mortar. The goal of the project is to reach a thermal conductivity lower than 0.03 W/mK for each material (with the exception of the bricks).
During the first phase of the Wall-ACE project, the development and optimization of the materials were carried on at the laboratory scale; then the products were tested in large-scale laboratory facilities and in-field conditions through the application in different demonstration buildings in Italy, France and United Kingdom. In this paper, an overview of the in-field monitoring activities on the demonstration sites and of the experimental facilities that were adopted to tests the developed products are presented.

## FIELD STUDY

In the following sections, the facilities and the case study building in which the developed materials were tested, divided by country, are presented.

### Italy

The building selected in Italy is located in Turin. It is a 1920’ building owned by ATC (Agenzia Territoriale per la Casa del Piemonte Centrale), a social housing organization partner of the project.
The apartment selected is used to measure the thermal performances of the internal plaster and the coating finish applied, respectively, in a thickness of 45 mm and 10 mm. The walls selected for the application of the materials are constituted by a solid brick cavity wall (~52 cm thick). For each aerogel-based material, two walls were selected, one adopted as a reference and the other retrofitted with the developed products. The aim is to compare their thermal resistance and the surface temperature to demonstrate the improvement achieved by the retrofit action.
In addition to the thermal measures, a set of relative humidity sensors were installed to correlate the thermal performance with the hygrometric condition of the aerogel-based materials. Moreover, the RH measurements allowed to identify when the drying process of the products ended, so when it was possible to consider the thermal resistance value reliable.
The monitoring phase on the developed products started in November 2018 and will continue until the end of the project (September 2019).

Figure 1. The Italian case study (ATC building).

**United Kingdom**
The approach taken was based on applying the Wall-ACE Insulating Plaster as supplied by project partners Vimark on the inside of an external wall of an apartment at the BRE Innovation Park at Ravenscraig, and adding a layer of insulating coating plaster on the inner side walls to mitigate thermal bridging effects. The plaster was allowed to dry out and afterwards the U-value of the wall was measured (as described below). In a second stage, a building simulation model was developed comparing a base case with uninsulated cavity brick façade and the improved case with the Wall-ACE insulating plaster in place (applied to all of the perimeter walls). The energy demand and occupant thermal comfort were analysed before and after the retrofit.
BRE conducted U-value measurements in an upstairs flat (Flat ‘F2’), that is a replica of a typical 1960s four-in-a-block unit, with the Wall-ACE insulating plaster added as a ‘retrofit’ measure. A first layer of Wall-ACE insulation was applied in September 2018 and a second layer in February 2019. The U-value of the external wall was measured at four positions during March and April 2019. Equipment was installed and heating supplied to the flat, and heat flow and temperatures were monitored at regular intervals.

Figure 2. Case study; the heat flux plates, thermistors and dataloggers recording the readings

**France**
Within the WALL-ACE project, several full-scale walls were built at CEA LITEN’s INCAS experimental platform in France (Le Bourget du Lac). In FACT (FACade Testing facility) two north facing walls were built on the ground floor (Figure 3). In test cell N°1 an aerogel containing outside render was added to a classic brick wall with a rendering made of plasterboard. In test cell N°2 an aerogel-based thermal plaster was added on the inside surface of a concrete block wall. In a PASSYS test cell, a wall containing all the developed products of the project was installed. The core layer is in aerogel plaster filled bricks, while the outside render was supplied by Quick-Mix and inside thermal coating by Vimark. Some artificial holes were added on the inside to include Toupret’s patching filler into this test. Figure 4 presents this installation.

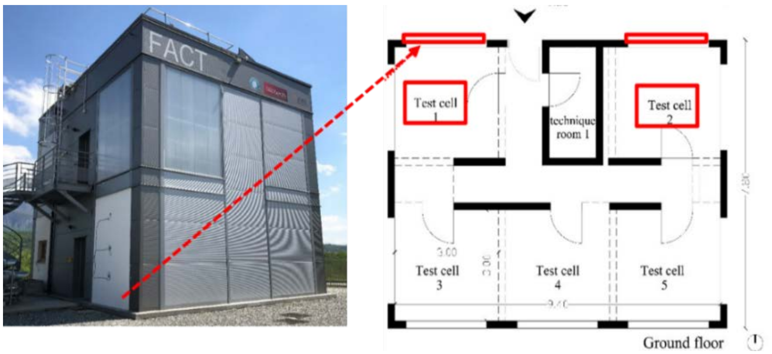


Figure 3. FACT with the two test cells on the North façade

Figure 4. PASSYS test cell installation (all project products)

Figure 5. The French case study (INCAS test houses)

As a demo activity, thermal coating finish was installed in a test room in one of the 4 test houses of INCAS's platform (Figure 5). This house is a recently built high energy performing one, where the test room is compared with a reference room from an environmental quality point of view: thermal comfort and indoor air quality are recorded.

## CONCLUSION

The paper shows the large-scale facilities and the case studies selected and adopted for the in-field measurements of a set of new super insulating materials developed in the framework of a European H2020 project (Wall-ACE). The in-field test of these products allows to define the wall thermal behaviour under different – "real life " - boundary conditions and when applied to a different substrate. The monitoring results allow comparing the actual performance with the one achieved in the laboratory conditions. Moreover, the monitoring datasets will be used to validate simulation codes used to perform analysis of different scenarios. The measurements in some case study will be performed until the end of the project (September 2019), so a large amount of data will be collected, and a deep analysis of the thermal performance will be possible.

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