Energy Efficient Ventilated Façades for Optimal Adaptability and Heat Exchange enabling low energy architectural concepts for the refurbishment of existing buildings.

E2VENT

SUSTAINABLE PLACES 2018
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E2VENT: an energy efficient ventilated façade retrofitting system. Presentation of the embedded energy storage system

Paul BONNAMY

R&D engineer - thermal systems

Nobatek/INEF4

INES 2018

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Introduction

- Paul BONNAMY
- Working in Nobatek/INEF4. French Research Technological Organization
- R&D on thermal systems for building applications –involved in national and EU projects
- Field: conception, simulation, tests and demonstrators' development

Overall presentation of the project

42 Months project

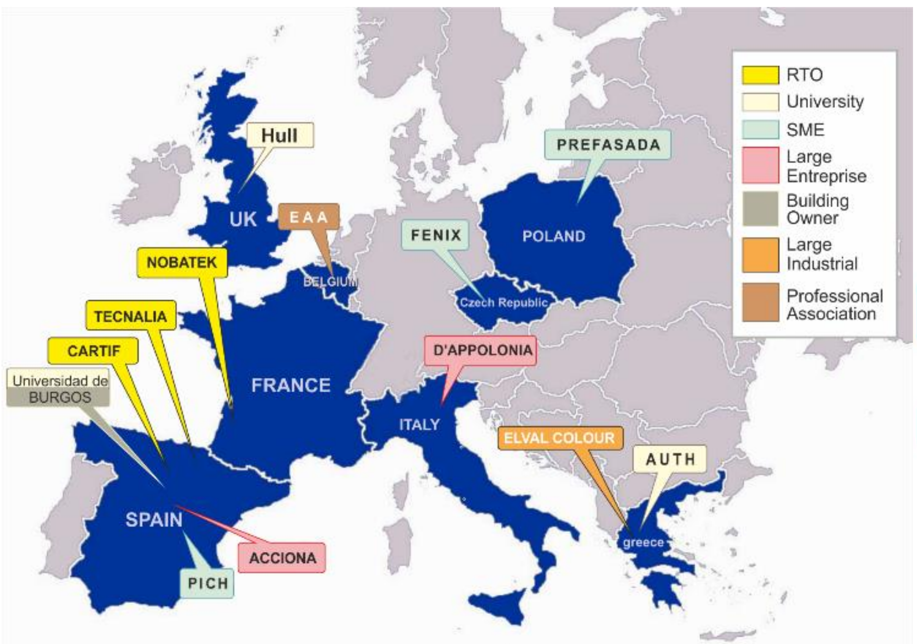
13 Partners

7 Work packages

3,4 Million budget

Call EeB02 - 2014: Adaptable envelopes integrated in building refurbish-ment projects

E2VENT main goal is the development of an energy efficient ventilated façade retrofitting system designed for an optimal and adaptable refurbishment of existing buildings.



Concept

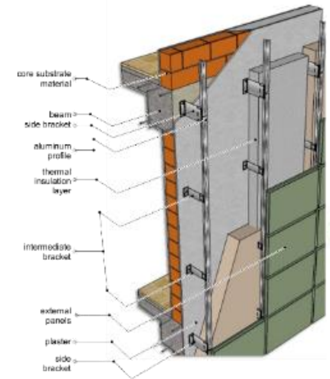
- We consider the 60’s – 80’s multi storey residential building stock characterized by:
  - High energy loss through the envelope
  - Bad Indoor Air Quality (no mechanical air renewal)
  - Poor aesthetics

Main idea:

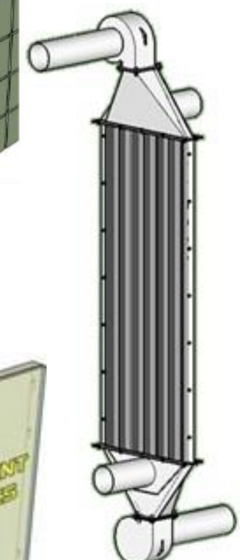
To tackle all those issues at once while giving value to the building

Concept

- The E2VENT system is an external thermal refurbishment solution with external cladding and air cavity embedding:



✓ **Smart Modular Heat Recovery Unit:** for air renewal with a double heat exchanger



✓ **Latent Heat Thermal Energy Storage:** based on phase change materials, for heating and cooling for peak shaving

✓ A building energy management system that controls the systems

Concept

- Installation on the outer layer of the existing wall:
  - External insulation → no thermal bridge
  - preserve the internal space
  - to limit the renovation work inside the flats.

- SMHRU Air renewal: for maximum indoor air quality while limiting thermal losses. Piloted with CO_2 sensors

- Aluminum cladding:
  - Better preservation of the wall
  - Wide range of colors → better aesthetics

- Objective:
  - compatible with Passivhaus standard ~25 kWh/m²/year

Systems: methodology for conception

1. Definition of requirements & specifications

Questionnaires


D.1.1
Value chain requirements & specifications

Contents:
1. Structural design & statics
2. Hygrothermal performance
3. Energy performance
4. Fire resistance
5. Sound protection

Market analysis


D.1.1
Value chain requirements & specifications

Contents:
1. Structural design & statics
2. Hygrothermal performance
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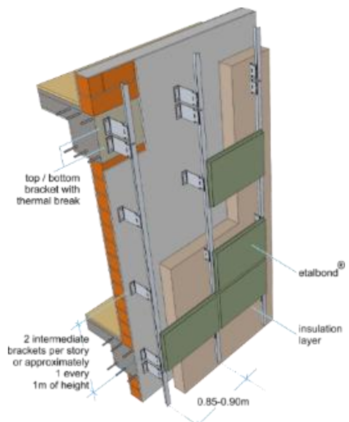
4. Fire resistance
5. Sound protection

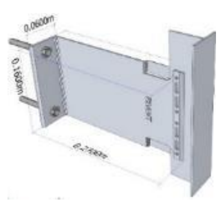
Specification report

2. Designs of the elements composing the system

LHTES



Integration inside the cladding air cavity



Anchoring

3. Prototypes

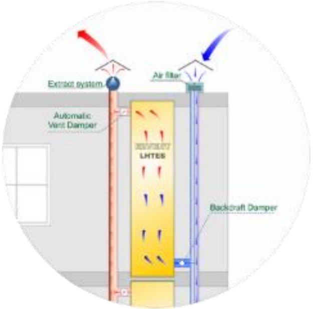
Prototype v1

4. Testing in laboratory

Systems: methodology for conception

5. Overall design of the E2VENT module and its integration in the façade

Façade view

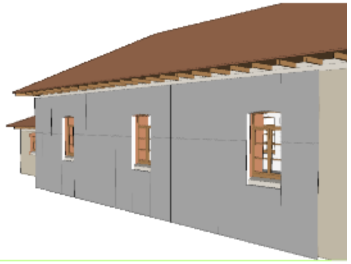


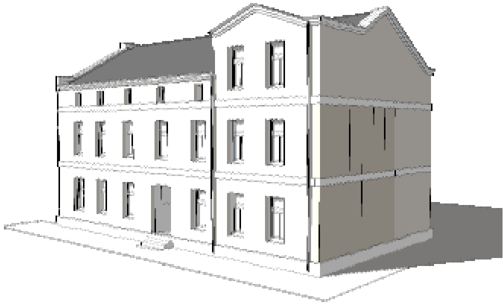
In/Outlet

6. Installation and testing on the test bench

Real scale test bench

7. Design & renovation plan for the pilots building





Demo-site: Burgos, Spain

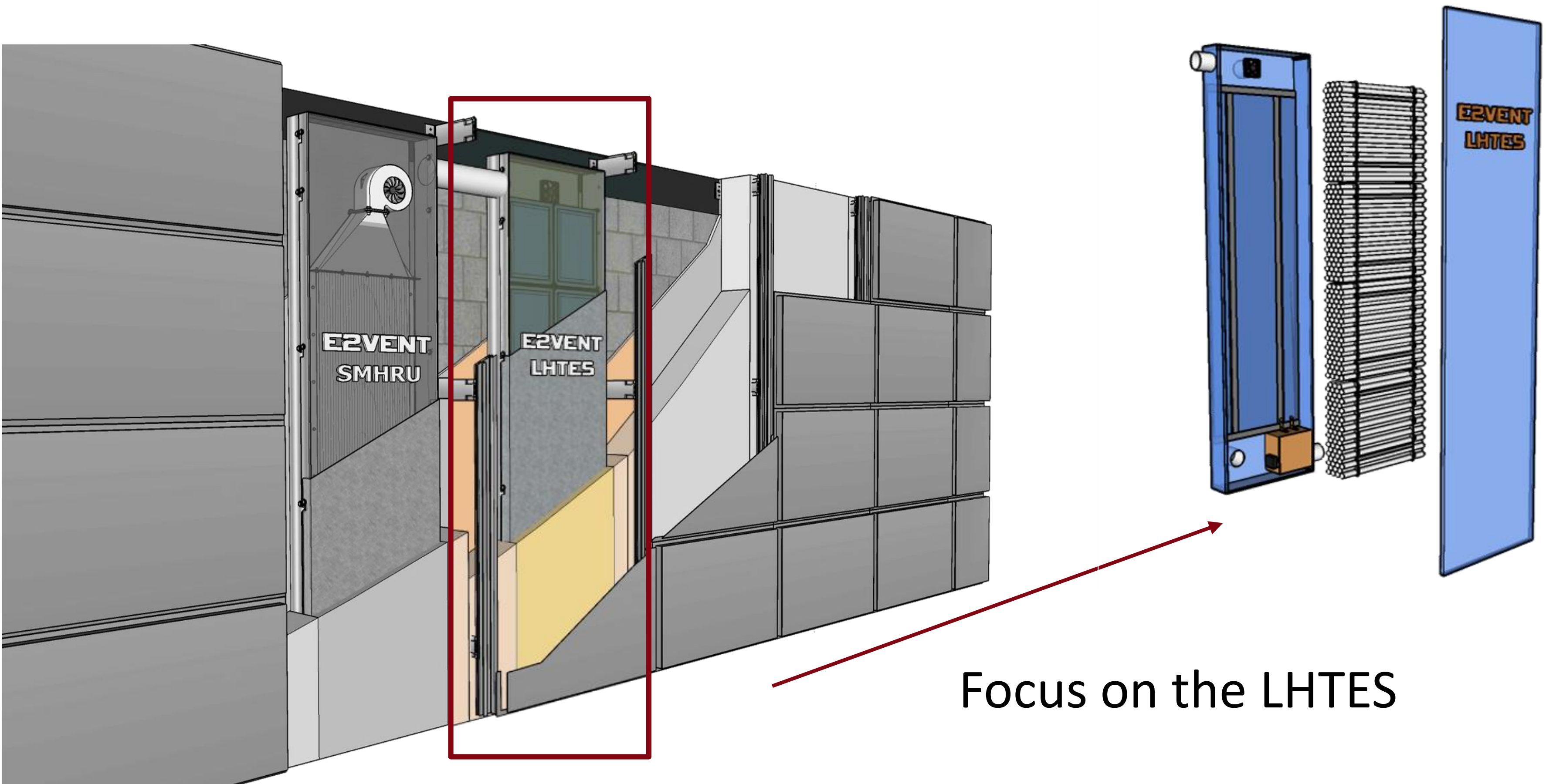
Demo-site: Gdansk, Poland

Focus on the HVAC systems

Smart Modular Heat Recovery Unit
for air renewal with a double heat exchanger

Latent Heat Thermal Energy Storage
for heating and cooling for peak shaving

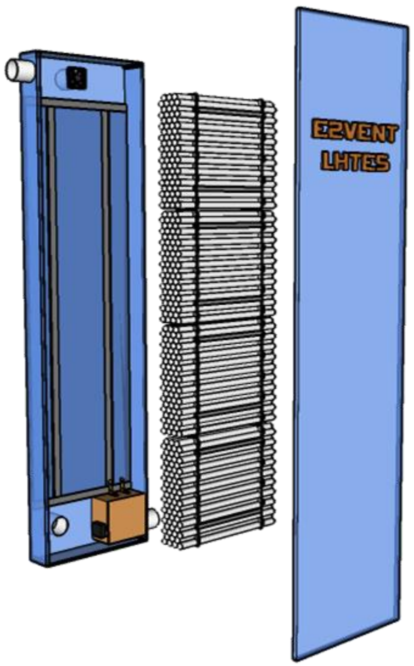
Focus on the LHTES



Focus on the LHTES

LHTES system: concept

- A system to store energy
  - For cooling in summer
  - For pre heating in winter
- Integrated in the width of the insulation layer
- 3 main components
  - Box in EtalBond
  - PCM encapsulated in tubes
  - Dampers and fan

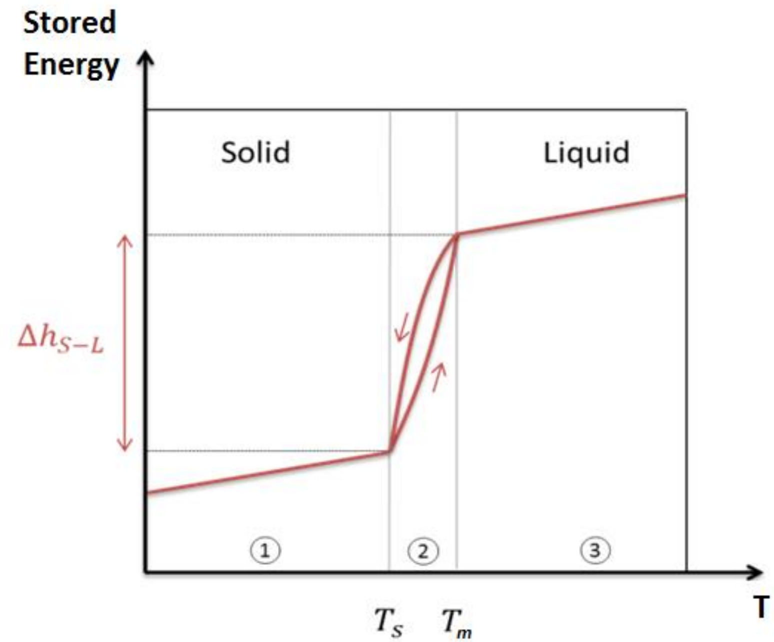


PCM Phase Change Materials to store heat

1. Phase change for temperatures close to T_{int}

2. To store great amount of energy in a restricted volume

3. The building's inertia is increased



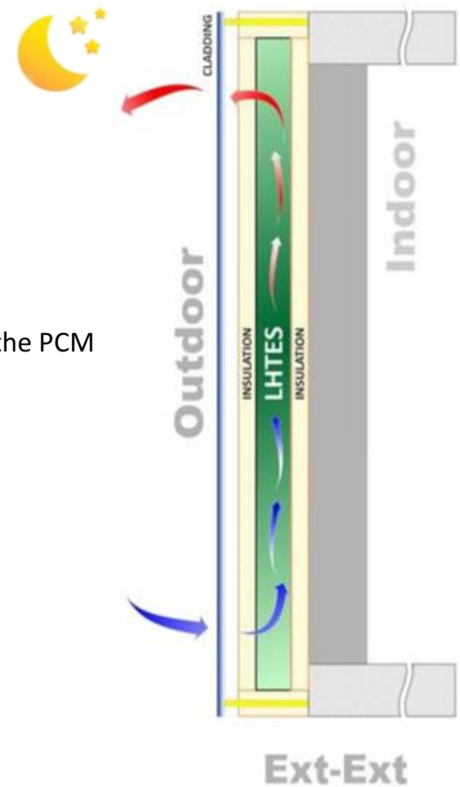
- Different types of PCM materials :

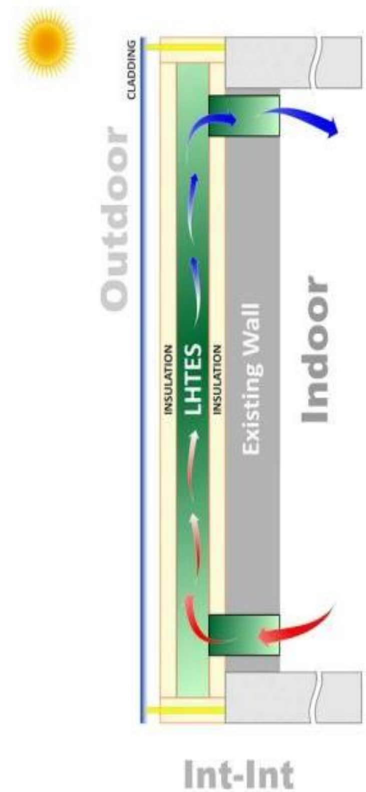
	Rubitherm **RT21**	Rubitherm **RT25**	Rubitherm **RT28**
Latent heat (J/kg)	180000	218000	235000
Liquid density (kg/m3)	770	770	770
Thermal capacity (J/kg/K)	2000	2000	2000
Conductivity (W/m/K)	0.6	0.2	0.2
Melting temperature range (°C)	19-23	22-25	26.5-28.5

LHTES system: concept

- Concept for cooling: two circuits EXT – EXT and INT – INT

Solidification of the PCM





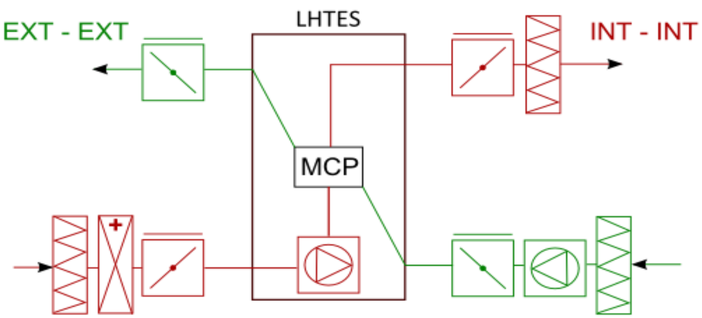
Melting of the PCM

At night, when T_{ext} is low, **EXT** loop is ON → store cold in LHTES

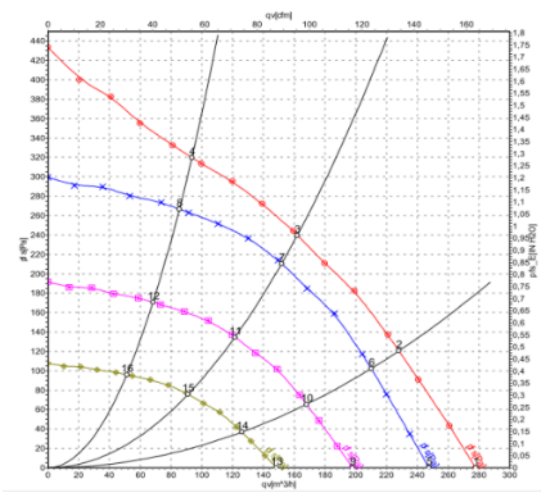
During the day, when T_{int} is high **INT** loop is ON → cool the zone

LHTES: design

- Selection of actuators:
  - Fan
  - Dampers
  - Sensors

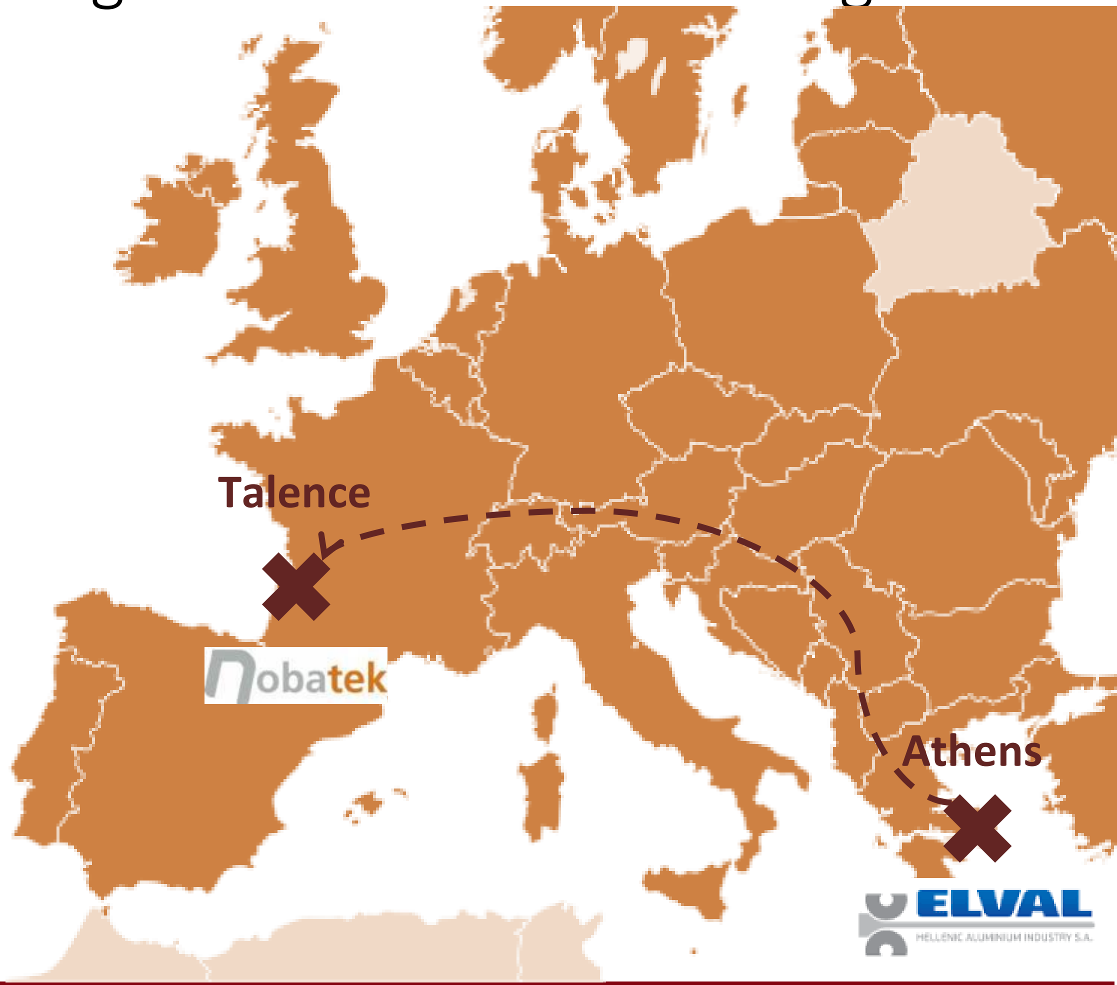


- And connection to the Building Energy Management System



LHTES: 1st prototype

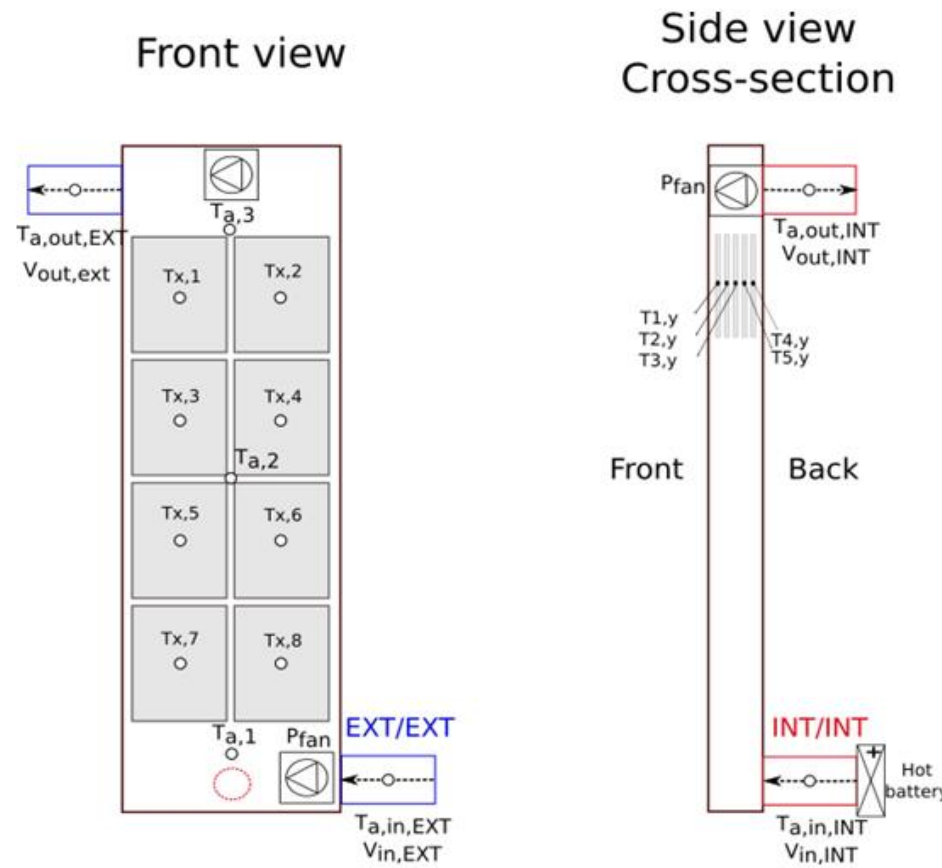
- From the manufacturing site to the lab for testing



LHTES system: Lab scale testings

Test Set-Up:

View of the LHTES system with PCM plates



Location of the sensors

Demonstration approach

- **1 test bench for real scale test**

→Objective: test installation, for 2nd prototypes

- **2 pilot sites**
  - Burgos, Spain
  - Gdansk, Poland

→ Objective:
  - Full demonstration
  - Comparison before and after
  - Social acceptance assessment

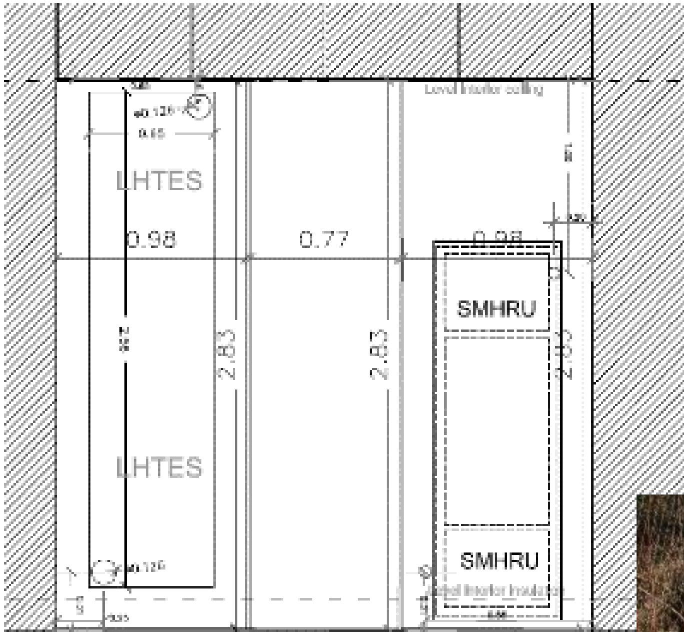
Real scale testings on a test bench

- For the prototype validation. Use of test bench in Anglet, France

Real scale testings on a test bench

- The test bench “BEF”
  - Three identical cells
  - Orientated toward south
  - 2,7*2,6m façade
  - HVAC systems
    - Heating / cooling / ventilation
  - Measurements
    - T , HR, v_air, consumptions

Real scale testings on a test bench



- Installation with all partners involved

→ feedback for installation

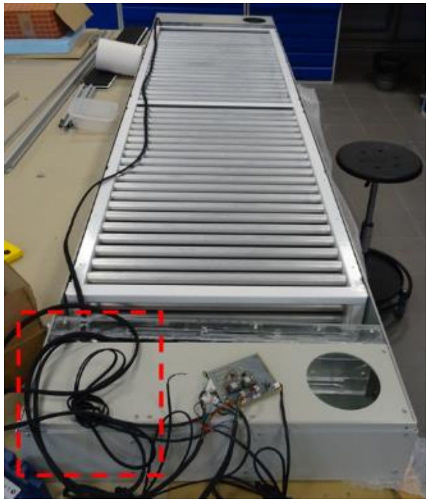
Real scale testings on a test bench

- After assembling and testing, some conclusions:
  - To ease installation
  - Less cables

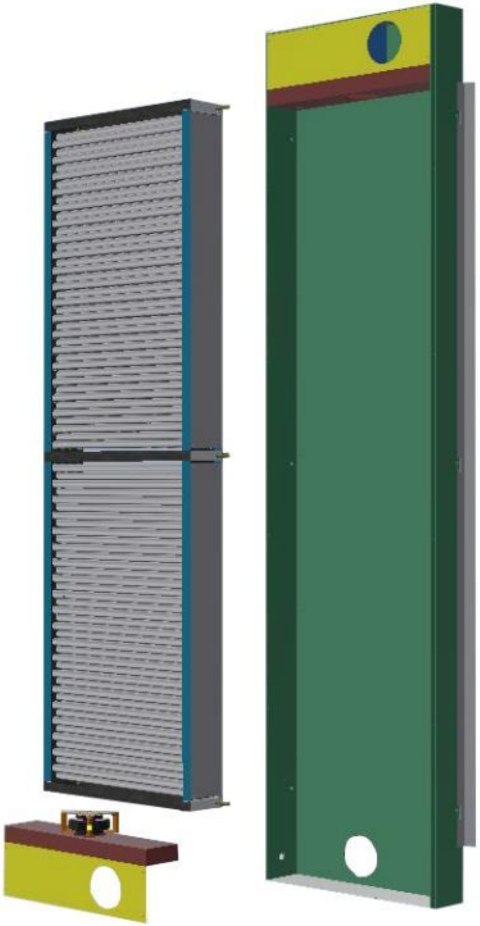
→ to be integrated in the final prototype

Final prototype design

- Improving the LHTES design :
  - to be facilitate its pre-assembly
  - to ease its onsite installation
  - to ease its maintenance



LHTES pre-assembly

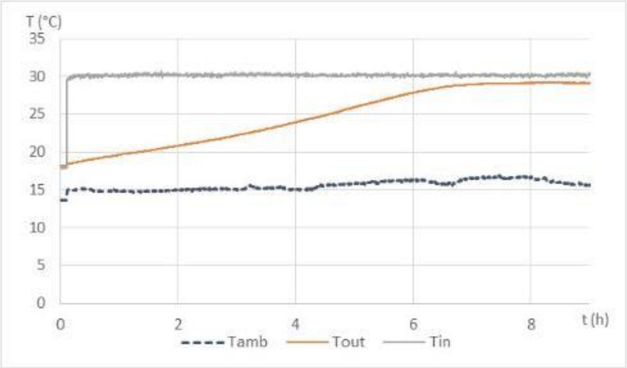


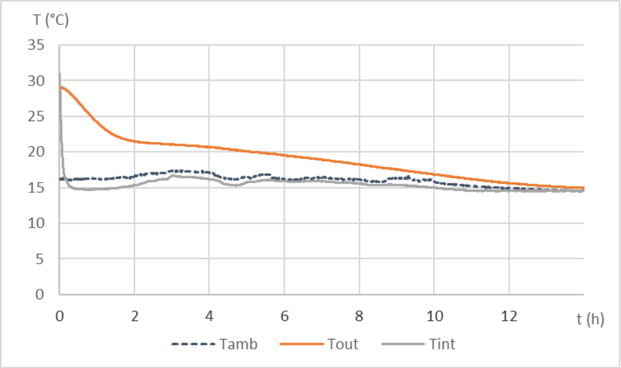
LHTES 3D model

Final prototype design

- Laboratory test

Experimental setup





Energy performance assessment

Final prototype design

- Installation in Burgos (Spain) pilot building

- Installed in October 2017
- Performance assessment will start in the summer period (from mid-June 2018)
- Social acceptance evaluation

Conclusion on LHTES

- Results:
  - One system
  - 140 kg → heavy
  - 2,5kWh stored and 500 W maximum power
  - Coefficient of Performance (COP) : 10
- Reaction to fire test to be done in 2018

Thank you for your attention.

Paul BONNAMY

NOBATEK/INEF4

pbonnamy@nobatek.inef4.com