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Identified Technologies for the HVACLab pilot plant

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Authors: ***Pablo de la Rosa***

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1 Introduction

This report is one of the Spanish fold of Deliverable D4.1.1., which aims at detailing the technologies that will be implemented within the pilot actions of the EMILIE project. Overall, 6 pilot plants will be installed: one per participating region. The 6 pilot plants are:

- SunLab in Italy, Venezia region, under the lead of AREA
- HVACLab in Spain, Andalousia region, under the lead of IAT
- SmartEE in France, PACA region, under the lead of Capenergies
- InfraSun in Slovenia, Ljubljana region, under the lead of IJS
- Glassolating in Spain, Aragon region, under the lead of CIRCE
- SunCool in Croatia, Kvarner region, under the lead of REA

The next sections :

- explain why the demonstration site for the HVACLab pilot action has been chosen,
- what are the energy saving challenges and
- present the technologies that will participate in the challenge solving.

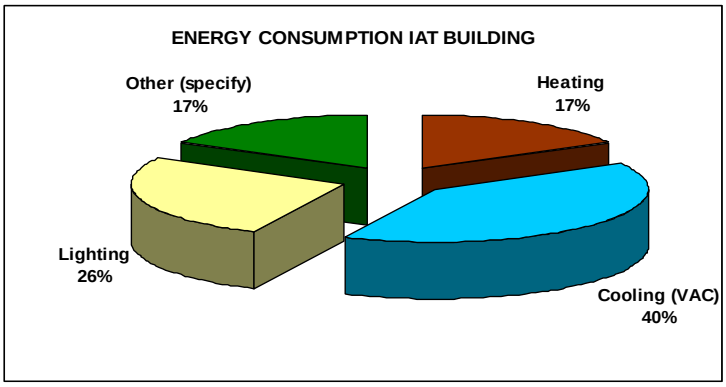
2 Presentation of the demonstration site

A key technology towards 2020 Nearly Zero Energy Building target fixed by Directive 2010/31/EU (EPBD), is the implementation of a set of energy efficiency measures into buildings. With these passive actions, which will depend on buildings characteristics, location, age, etc., it could achieve an important energy savings, overall due to reduction of energy demand of the building. Some of these energy efficiency measures would be related to improvement/replacement of isolation material into facades or on roof, replacement of windows to another with thermal separation, installation of sunscreens and shading elements in windows, improvement of HVAC system performance, etc.

On the other hand, as it can be seen below, as challenges for energy savings that the current status of the IAT building shows, it can be mentioned on one hand the consumption of HVAC system, overall under operation in cooling mode in the summer period, and on the other hand, consumption related to lighting system (in most of office buildings the lighting consumption is too high). So, analyzing the challenges for energy savings that the building presents and the scope of the EMILIE project, it is going to be addressed the reduction of the HVAC system, and being more specific, it is going to try to decrease the cooling demand in the summer period.

Average energy consumption within the last three years [MWh/year]	2012	415
	2011	404,6
	2010	373,1
	2009	344
Types of consumed energy sources	100 % electricity	
Break down of energy consumption by energy source [MWh/year, €/year]	453 MWh/ year	
CO2 emission production break down by type of fuel consumed [tons of CO2/year]	113 tones of CO2 / year	
Break down (assumption) of energy consumption by consumption area [%]	Heating 17 %	
	Cooling (VAC) 40%	
	Hot water 0	
	Lighting 26%	
	Other (specify) Computers 9% Lifts 6 % Water 2 %	

Table 1. Energy consumption references of the IAT building



Agree with everything commented so far, inside EMILIE project is being developed the HVACLab ("HVAC technology Lab for office buildings") pilot action. The objective of this pilot plant is improve the performance of the HVAC system of the IAT building by means of improvement of insulation of the distribution facilities and other measures of energy efficiency in order to increase the COP of whole system. To carry out this pilot action, previously of implementation of energy efficiency measures, have been developed a theoretical models of the building so as to test the improvement of the energy behaviour of the building.

As general information of demonstration site, it can be mentioned that IAT building was built in 2000, and has an exclusive use as offices for the IAT staff with a summer opening hours from 8 to 15:15 and the rest of the year from 8:30 to 18:30, Monday to Friday. The main facade of the building is oriented 20° North-East. It has a floor area of 484.3 m2 and a height of 16 m. Besides, there is a basement of 3.5 m high, a ground floor that is elevated above the ground 1.2 m and three floors of 3.7 m each. The roof colour is brown, the colour of walls are light brown with a 25% of glazing.

Figure 1. View of the main entry of IAT (Sevilla)

Figure 2. Location and view of main facade of the IAT building (Sevilla)

In the central part of the building there is a courtyard of 96.5 m2 which is covered by a canopy of light colour to reduce the losses of air conditioning. Next to one of the facades there is a building of similar height, and is surrounded by vegetation of medium height.

Regarding HVAC system installed in the building, it consists in two different air conditioning control systems, one of them for the ground, first and second floor (installation of four tubes with heat pump and air transfer units of variable flow), and the other one for the third floor (independent units of variable flow, Roof Top). The basement and the stairs are not air-conditioned. The technical specifications of these devices are shown below:

Reference / type	Condensation	Min. cooling rated power (kW)	Min. heating rated power (kW)	EER	Rated electric power (kW)
Heat pump 1 / 4T	Water	126	170	>3.2	31
Heat pump 2 / 4T	Water	126	170	>3.2	31

Model	Rated Electric Power - Cooling (kW)	Rated Electric Power - Heating (kW)	Cooling Rated Power (kW)	Heating Rated Power (kW)	Flow pump (m^3/s)	Flow Rated Power (kW)
Roof top 1	26.12	21.91	52	56.7	3.44	1.5/4
Roof top 2	26.12	21.91	52	56.7	3.44	1.5/4

Figure 3. Heat pumps & Roof Top

3 Description of the pilot plant

Once demonstrated why the pilot actions is going to be performed and which are the challenges for energy saving to face, it is going to describe the technical characteristics of the pilot plant.

The pilot plant consists in two different actions, on one hand are being developed different theoretical models both the building and HVAC system, and on the other hand it will be implemented energy efficiency actions both into HVAC system and IAT building. Then, IAT building has been modelled by means of EnergyPlus, in order to analyze current energy demand of building and so as to check what is the energy demand after EE measures implementation, and by means of CALENER (a official national software to the energy certification of residential buildings) so as to check the improvement of the energy tag of the building. Besides of that, it will be done a simulation by means of the GaBi software so as to develop a Life Cycle Assessment of whole HVAC installation, defining the reduction of greenhouse emissions with the innovation developed.

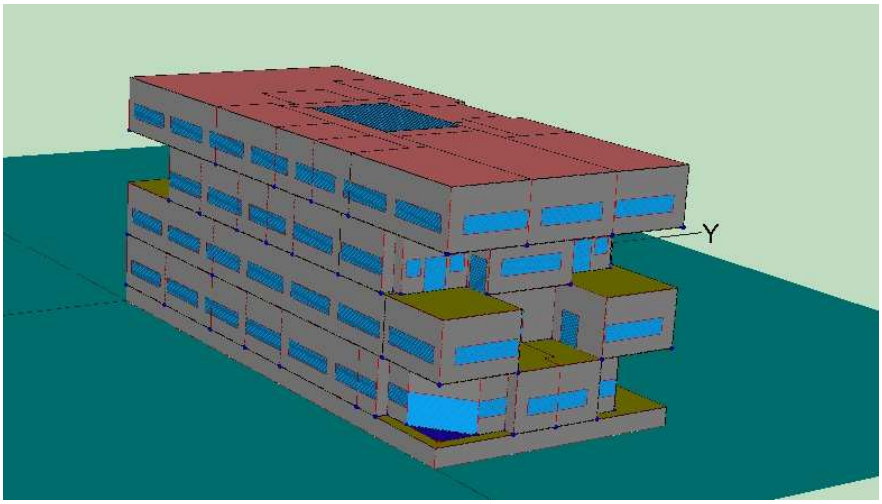


Figure 4. CALENER model of IAT building

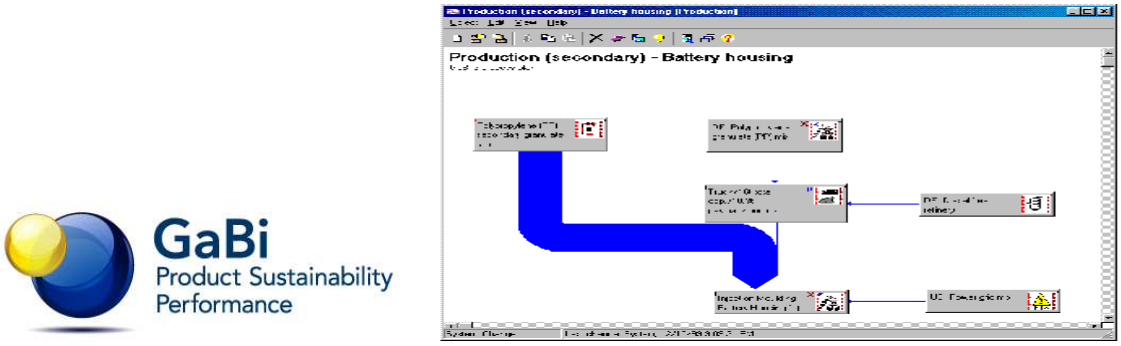


Figure 5. GaBi software interface

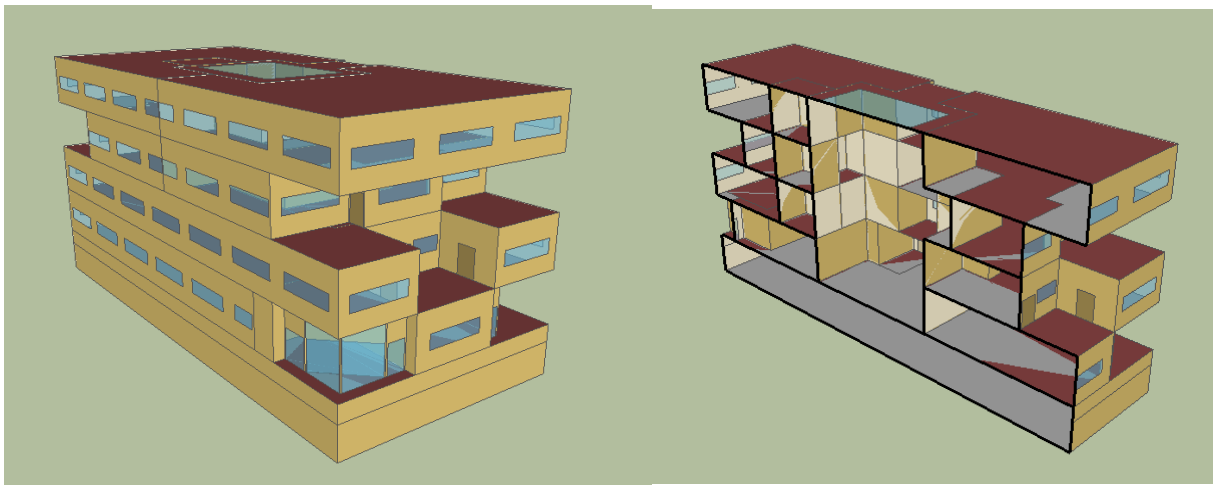


Figure 6. Energy Plus model of IAT building

On the other hand, it has been defined different solutions that will compose the pilot plant, both those related to improvement of insulation of distribution system and those of efficiency energy to improve the COP of whole system. The election of the EE solutions has been based on its cost-effective from a energy savings point of view.

All solutions, that will be implemented into HVAC system and also will be included in the different models developed (EnergyPlus, CALENER, and GaBi softwares), are the followings:

1. Replacement of isolation material into distribution system of HVAC system

a) Replacement of isolation material into water distribution system (pipes) located on the roof of the building by armaflex foam, and coating of all facilities by a plate of aluminium.

b) Isolation by means of armaflex foam of drive pumps and heat exchangers located in first floor (engine room). Consist in 8 pumps of 4" diameter x 25 mm, and 4 exchanger plates of 330x170x850 mm.

c) Isolation of HVAC machines located on the roof (Air Handling Units) by means of armaflex foam of 40mm of thickness around machines. The isolation will be protect by steel plate folded in their ends.

Figure 7. Armaflex foam

2. Installation of flow meter

Two digital flow meters HoneyWell EW773 that can measure temperature and volume flow will be installed in the engine room for both supply and return distribution systems. This facility will be the first equipment to install, it has to be installed previously to the other energy efficiency measures implementation, since by comparison of measures before and after of pilot plant actions implementation, it can be checked the improvement of the HVAC system performance.

Figure 8. Flow meter HoneyWell EW773

3. Installation of sunscreens

It will consist in installation of sunscreens composed by 4 windows of 800x1250 mm, with non-reflective effect. Total of 20 set of windows, composed by 4 windows each one of them (80 windows).

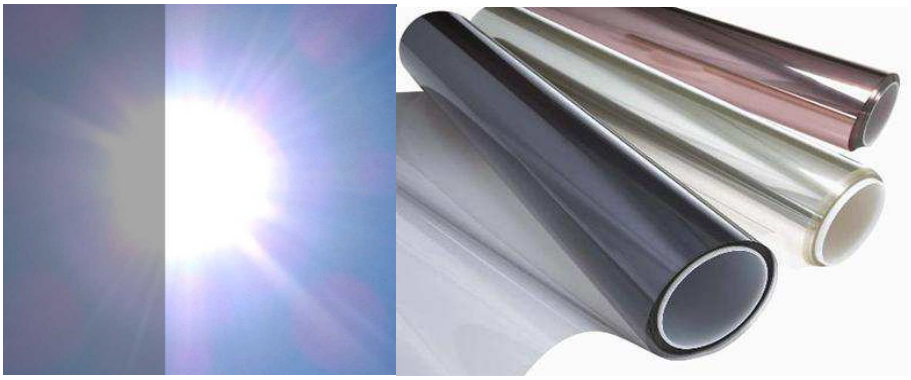


Figure 9. Sunscreen effects

4. Replacement of sunshade of the skylight

Installation of a new sunshade on the skylight which will consist in a flat sunshade, over rails, microperforated, fireproof, 6x10m. This sunshade can be manually rolled up for periods in which heating demand is higher.

5. Reparation of the skylight

Reparation of the part of the skylight in which is detected some breaking parts.

6.Installation of curtain slats in some windows

Installation of 4 curtain slabs in the ground floor on the building, in the façade which has southwest orientation. These curtains slabs have the following proportions: 156 x 400 mm, 180 x 240 mm, 455 x 240 mm, and 165 x 240 mm.

Figure 10. Curtain slabs

Besides of checking energy demand reduction by means of Energy Plus, the improvement of the energy certification by CALENER, the reduction of the environmental impact by GaBi, and the improvement of the performance of HVAC systems (heat pumps) by flow meters, it will be done other actions so as to check energy savings achieved after pilot plant implementation.

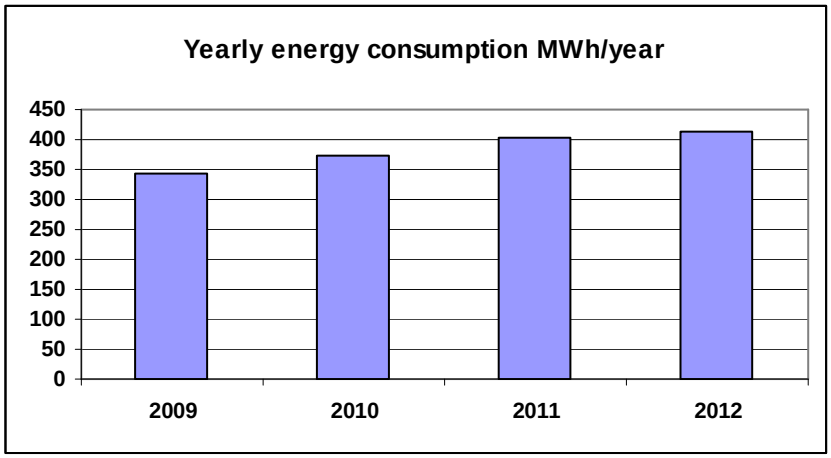
On one hand, whole HVAC system will be monitored, by means of energy analyzer (FLUKE) and other equipment like it, in order to measure the energy consumption (electric) of the system in each moment, and in case is detected a high or an unusual energy consumption, to find the cause of this consumption. This monitorization will be performed, from before energy efficiency measured implementation to the end of pilot plant life.

On the other hand, the level energy savings achieved thanks to pilot action will be also analyzed by comparison of electric invoice (after breakdown of it) of the previous years. This comparison will be carried out for the same periods/months of the year.

4 Expected impacts

4.1 Energy savings

With this pilot action is hoped to achieve an important energy savings. As is shown in the second section of the document, the energy consumption of the building in grows up each year, something that if is attached to the constant increase of electric cost, is translated in a important problem for the company.



The objective of energy savings to achieve by the HVACLab pilot plant is to reduce at least the energy consumption in 15% in the months where the energy demand is higher (summer season). Thanks to the monitorization that will be performed, it could be identified the most criticism energy consumption factors, area of the building, times of day, etc.

Before pilot plant implementation, it does not know which of the energy efficiency measures will have more weight in the energy demand reduction, although thanks to some results obtained by Energy Plus model, It is considered that measures related to replacement/installations of passive elements in windows will have a high energy saving impact.

4.2 Other environmental benefits

Concerning energy savings that can be achieved with HVACLab implementation, it will be a reduction of GHG emissions related to this consumption, so it fosters to moving towards a “low carbon economy”.

4.3 Social impact

Once the project ended the pilot plant will be implemented in the IAT office building. This site constitutes the “HVAC technology Lab for office buildings” which will be open to all potentially interested users.

This Lab (networked with the other pilot plants) intends to contribute at creating preconditions for making access to innovative technologies easier on a transnational level.

4.4 Financial advantages

As financial advantages, it could be mentioned the energy cost savings related to energy savings achieved by pilot plant implementation. The payback period of the investment will depend on the energy savings achieved.