Mediterranean Building Energy Efficiency Strategy

Pilot Activity 3.2 Task 5

Test under real conditions of innovative products for the building sector

Lead Author:	AREA Trieste	Other Authors:	Regione Piemonte
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0. INTRODUCTION

Innovative products and energy saving systems for construction sector, even more than traditional and consolidated ones, need to face the challenge of respecting both market demand and legal mandatory requirements and standards. Instrumental tests are by this point view an important resource to predict and simulate the performance of the single building components or equipments under real conditions, to avoid as much as possible discrepancies between the expected and declared performance and the performance of the element in the “as built” stage.

1. OBJECTIVES

The main objective of the action was to test and show the importance of an on-site monitoring of the performance in the improvement of the products by companies, to better suit the market requirements and integrate the traditional tools for performance evaluation at the design stage (i.e. modeling software).

The pilot action was also aimed to provide brief guidelines for efficient on site test of the selected categories of products abd solutions for energy refurbishment.

2. METHODOLOGY

2.1 Choice of the innovative products

Two solutions were selected by AREA Trieste and one by Regione Piemonte.

Partner	Solution
AREA Trieste	Dynamic simulation and optimization software for energy refurbishment of buildings
	Software for the simulation of the performance of integrated systems for power generation
Regione Piemonte	On site monitoring of a modular roof element (also selected for LCA study in task 3)

2.2 Test measures on the thermal/electric performance

A study under real performing conditions of 3 innovative products was developed.

All studies were performed by the following steps:

- Set up of a pilot installation (pilot element) on a selected site
- Set up of the operationals parameters
- Measurement of thermal and/or electrical performance in accordance with the specific technical standards

<u>On site monitoring of a modular roof element</u>

The modular roof element was subjected to an instrumental test of the thermal performance with the use of a heat flow meter.

Testing methodology: ISO 9869, characterized by:

- high difference of temperature between internal and external environment (> 15℃)
- 72 hours as minimum duration
- Constant conditions in terms of solar lightning during the day

A pilot element was used for the monitoring activity, with a design reproducing the operational conditions of the roof element.

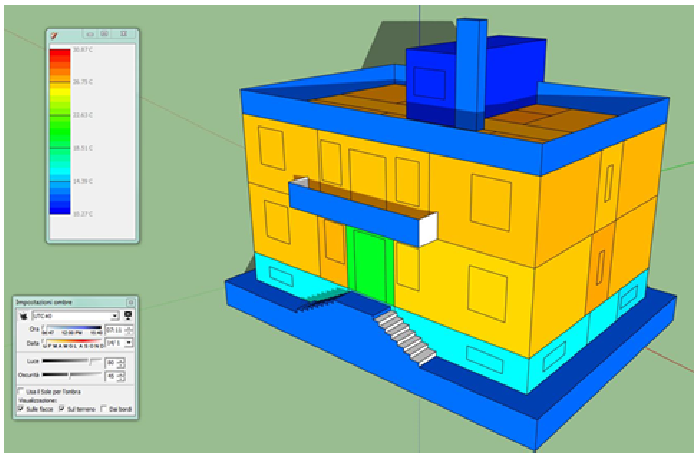
<u>Dynamic simulation and optimization software for energy refurbishment of buildings</u>

The purpose of this activity was to evaluate the impact of the use of innovative design techniques, such as the *dynamic simulation* of buildings coupled with optimization software, with the purpose of estimating the economic return and the primary energy saving that can be obtained in a hypothetical renovation of the building envelope and of the systems for the generation and distribution of thermal energy of public buildings used as offices.

The study was developed as follow:

- Energy Audit on the two existing buildings.
- Identification of possible energy improvement scenarios.

- Energy calculation under monthly semi-stationary conditions for the actual situation and the possible energy improvement scenarios.
- Energy calculation under dynamic conditions for the actual situation and the possible energy improvement scenarios.
- Estimation of the costs for the different energy improvement scenarios.
- Comparisons between the results obtained with the monthly semi-stationary and the dynamic methods



<u>Software for the simulation of the performance of integrated systems for power generation</u>

The aim of pilot action has been the developing of a software dedicated to the simulation of the performance of integrated system of power generation. The software ENPAT has been validated on the basis of records of data collected on systems working in real operative conditions. The analyzed system were:

1. a unit for the combined production of heat and electrical power based on an internal combustion engine developed by the company Enegifera;
2. a unit for the combined production of heat and electrical power based on a microturbine developed by the company Turbec;
3. three photovoltaic systems equipped with the most efficient modules on sale in the period of the drawing up of the project.

The ICE based CHP unit and the MTG based CHP unit are both fed by natural gas, even if the MTG system can be fed also with fuels characterized by different lower heating values.

Different steps were developed:

- Step 1: assessment of the performance of the system and its components;
- Step 2: assessment of the system efficiency through the correlation between the actual measurement of the solar radiation and the produced energy;
- Step 3:assessment of the degradation of components and performance;
- Step 4: assessment of the efficiency in “field test” conditions;
- Step 5: identification of the most suitable and more cost effective solution for the production of electricity by small plants (software ENPAT).

3. RESULTS

<u>On site monitoring of a modular roof element</u>

The results of the performance was in line with the regional regulatory standards, but different from the results obtained by traditional static modeling and calculation softwares used by the manufacturing company. This confirmed about the opportunity to implement this kind of site test as a complement of the other traditional tools.

<u>Dynamic simulation and optimization software for energy refurbishment of buildings</u>

The main results were that:

1. The experimented ones are economically onerous simulations for these reasons:
   a. It is necessary to carry out detailed energy audits to evaluate how the premises are used, the internal loads and the electricity consumption of lighting devices and of the other electrical equipment and appliances.
   b. Long times are needed to obtain a result that can be used;
   c. It is necessary to carry out many cascade calculations to refine the calculation model and to make it comparable to the actual behavior of the building;
   d. it is necessary to use specialized staff for simulations.

2. It is necessary to interpret the results obtained with the simulation, in fact:
   a. The analyses on existing buildings, not provided with thermal regulation, lead to results that diverge a lot from those obtainable with the monthly semi-stationary method
   b. The dynamic analysis depends significantly on how the premises are used and on the internal loads.
   c. It' necessary the elimination of unreliable results in simulations, caused by errors in data input.

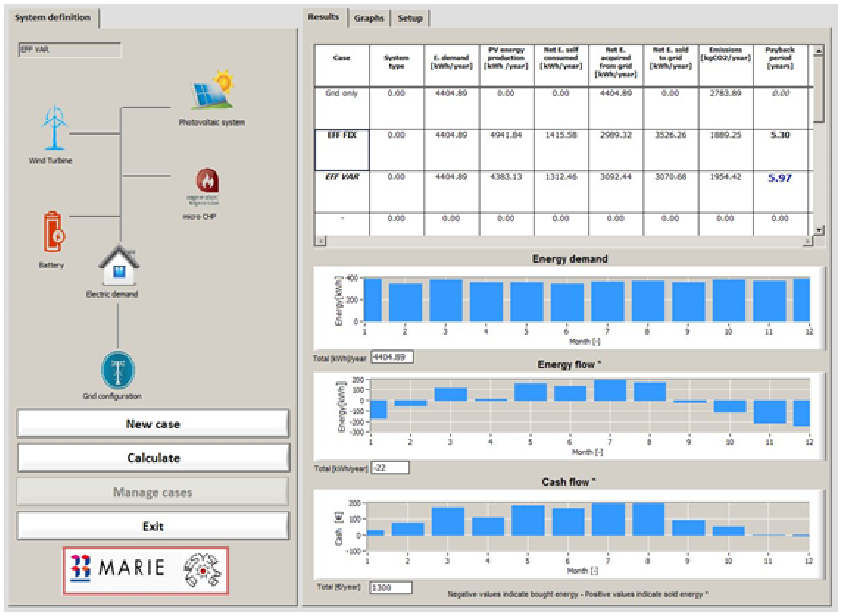
Software for the simulation of the performance of integrated systems for power generation

The activities demonstrated the possibility to reach the following environmental benefits:

- lower CO2 emissions;
- lower pollutants (NOx, CO) emissions;
- lower fuel consumptions.

In addition, the experimental activity planned by the pilot action permitted to:

- evaluate the parameters of operation of the CHP unit and its components;
- monitor the operating variables affecting the performance of the system;
- compare the performance, for the same environmental conditions, of the actual performance and profitability of co-generators based on internal combustion engine fueled by natural gas with those with gas micro-turbines;
- develop simulation and analysis tools aimed at saving fuel and reducing harmful emissions in buildings (ENPAT).



The following main difficulties were registered:

- Field test may be hampered by technical, human and safety factors;
- Sensors and transducers of good accuracy price is falling but still to high for large scale diffusion of «monitored plants»;
- Field data, especially in off-design conditions may differ from manufactures specifications unpredictably.

4. CONCLUSIONS

The pilot action confirmed that the adoption of innovative protocols for energy monitoring of components could help the market to better characterize the performance of solutions for refurbishment, reducing the gap between the expected performance at the design stage and the performance registered at the operational stage.

The wide use of pilot elements could also help to better simulate the performance of the single elements in the framework of the building, providing better quality information for the application of the existing environmental evaluation softwares and schemes.

Against the difficulties described in the results, pilot activities also led to the following conclusions:

- dynamic simulation can allow to have more indicators available and to evaluate the efficiency of interventions, the energy impact nd the impact on the internal heat and humidity conditions more effectively;
- the dynamic simulation approach allows to simulate the building with maximum hourly time intervals in order to take into account the effect of the building envelope alone and of the envelope together with systems and installations;
- an innovative element is represented by the possibility of coupiling the dynamic simulation with optimization algorithms in order to explore alternatives comparing energy, economic or environmental objectives.

5. ANNEXES

5.1 Technical report on the performance of the selected solutions (D 3.5.2)

5.1.1 Dynamic simulation and optimization software for energy refurbishment of buildings

5.1.2 Integrated system for power generation

5.1.3 Micro-cogeneration system based on an internal combustion engine

5.1.4 Micro-cogeneration system based on micro turbogas turbines

5.1.5 Photovoltaic arrays installed on building Q2 and building CTB

5.1.6 Photovoltaic arrays installed on building Q

5.1.7 Modular roof element