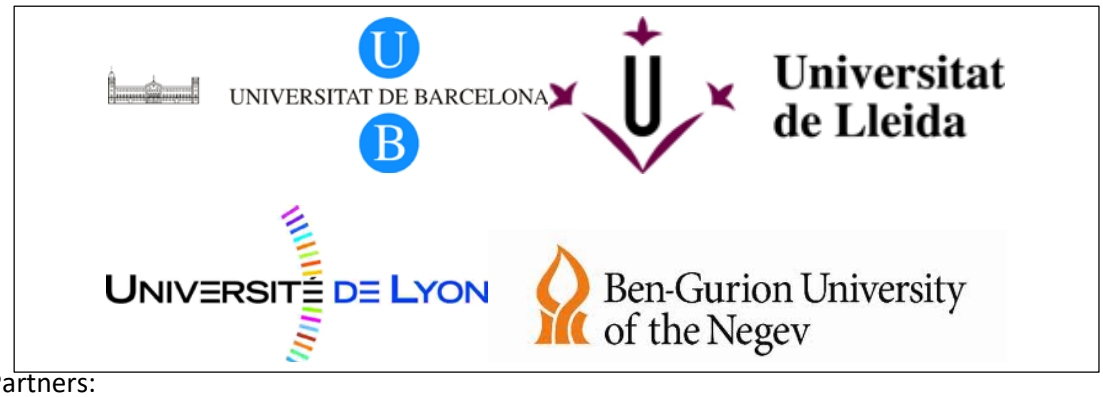
INNOSTORAGE – USE OF INNOVATIVE THERMAL ENERGY STORAGE FOR MARKED ENERGY SAVINGS AND SIGNIFICANT LOWERING CO_2 EMISSIONS

Beneficiaries:



Partners:

D7.2 - Report on Staff Exchanges

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Contents

1 Objectives

The objective of the secondment was to investigate the effect of Model Predictive Control (MPC) method, as a well-established technique, in the building for space heating purpose. The aim of the MPC application is to take advantage of the low-cost night-time electricity rates and the diurnal solar energy, which in turn culminates in the reduction of the global and peak energy demand as well as the energy cost. In addition, the secondment was aiming to continue the collaboration between University of Auckland and University of Lleida, in the thermal energy storage area.

2 Introduction

Studies show that almost 40% of the energy consumption in worldwide are associated with building sector, in which case space heating and cooling is responsible for approximately 50% of the energy consumption[1]. So, design professionals, especially architects and engineers are experiencing unprecedented requisitions to apply novel approaches for the sake of improving the thermal efficiency of the buildings. The integration of thermal energy storage (TES) systems to the building can satisfy the growing energy demand as well as the inevitable environmental pollution caused by the energy consumption[2]. On the other hand, the development of computer technologies and modeling techniques, have enabled the prediction of energy consumption in the buildings[3]. MPC has attracted the attention of the researchers in the area of energy efficient buildings. Taking into account the internal gains, equipment, weather and cost, the required thermal comfort will be achieved through MPC technique[4].

This work has been focused on the numerical study of the MPC implementation in a building for space heating purpose.

3 Description of work

To study the effect of the MPC strategy on energy reduction and cost saving of a space heating, a computer modelling was developed. The MPC method was applied to a system including solar air collector, thermal energy storage in the form of heat exchanger and a demand which was the room to be heated.

4 Materials and Methodology

The numerical study of MPC strategy for a building was conducted via Python software and Scip optimizer. In fact, a control model was developed to minimize the energy consumption and cost of a single hut for a specific heating demand profile. To satisfy the demand a solar air collector was embedded to the hut. The energy coming from solar air collector can either head directly to the room or to the heat exchanger which includes phase change materials (PCM) and acts as a thermal energy storage system. In case the energy captured by solar air collector is not

sufficient to provide the demand, an electrical backup heater will supply the remaining energy. Figure 1 illustrates the schematic view of the system operation.

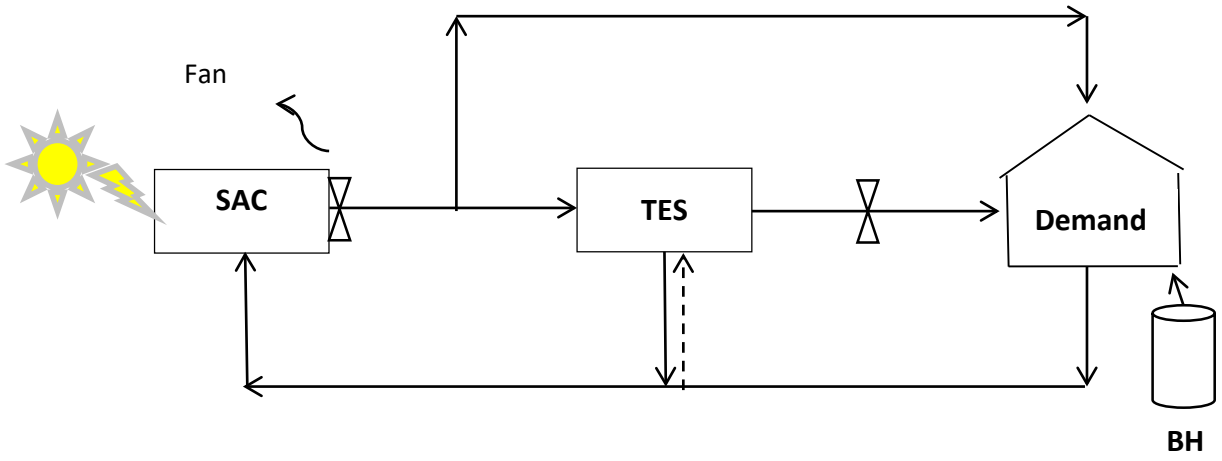

Figure 1: Operation scheme of the system

These findings rests on the assumption that the whole thermal storage medium is at the same temperature in order to reduce the computation effort and time[5].

5 Results

The MPC technique successfully applied to the system, which results revealed a reduction in energy consumption and cost. Figure 2 demonstrates the result of the modelling for the first day of winter in New Zealand. It can be seen that at around 7 pm in the afternoon, where the grid price reaches to the highest value, the TES starts to release the energy and provide the demand.

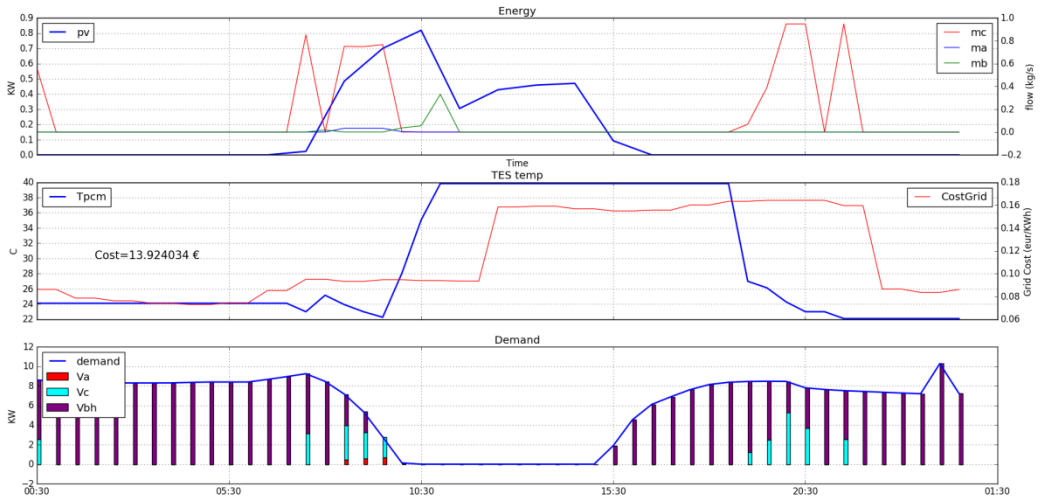

Figure 2: The one-day simulation with MPC method

Furthermore, modelling results of the first day show that the incorporation of the TES to the system could save about 15% of the electricity cost .

Va: Energy provided from solar collector directly to the demand

Vc: Energy provided from TES to the demand

Vbh: Energy provided from backup heater to the demand

6 Outcomes or future work

During the two-month of the secondment the numerical study of the MPC application for a hut was achieved, which is expected to be published in an international journal.

7 References

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8 Assessment

The secondment provided me the opportunity to have such an interesting and exciting experience during my PhD life. Through my stay in Lleida, I not only got acquainted with a very distinguished group in the thermal energy storage systems, but also visited a new country with lovely and nice people.