As a second hypothesis, it has been studied the effects of night cooling on indoor thermo hygrometric conditions. It was used a detailed geometric model of a room considering active control solution and the worst conditions of exposure (West exposure). The room has been divided into two thermal zones, where the zone_1 represents the volume portion of the false ceiling (Fig. 10a); two ventilation opening grids have been introduced at the top and at the bottom of the room and it was created an airflows network [6] with a scheduled control (Fig.10b).

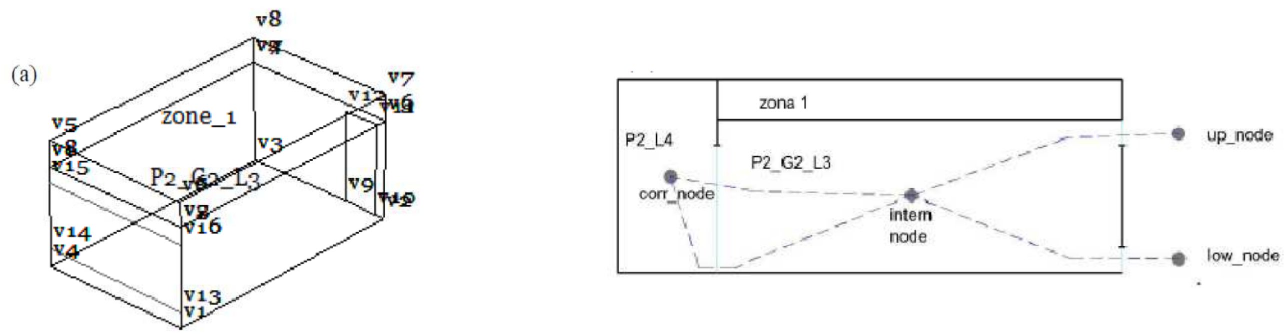

Fig. 10. a) ESP-r model of room with West exposure adding ventilation grids; (b) Airflows network diagram to represent natural ventilation in the room

It was performed a simulation of db T comparing three different strategies to solve summer overheating:

- Active control, considering the cooling plant only;
- Shading system, introducing a shading system to the windows to protect the room from direct solar radiation;
- Airflow network, considering all previous strategies and natural ventilation (night cooling).

Db Temperature decreases significantly thanks to the addiction of a shading system to the transparent facades. The addiction of a natural ventilation system does not have a significant improvement on thermo hygrometric conditions within the room: the gap between Zone db Temperature and Ambient Temperature in still high during the night (Fig. 11a). About Zone Relative Humidity, natural ventilation maintaining RH value within the comfort band (40-60%).

Stronger airflow will be induced when there is a large vertical distance between inlets and outlets openings, and when there is a large difference between indoor and outdoor temperatures.

In this case natural ventilation was not sufficient to activate an airflows convection in the room because of the small distance between opening grids placed at the top and at the bottom of the room. Moreover, the west front is also not directly exposed to the night breezes, infact the main wind direction in July and August is South-North. For these reasons the only good solution to improve the indoor comfort in the rooms of the block 2 is the use of external solar shading on the double glazing facade or a new technological solution for the facade.

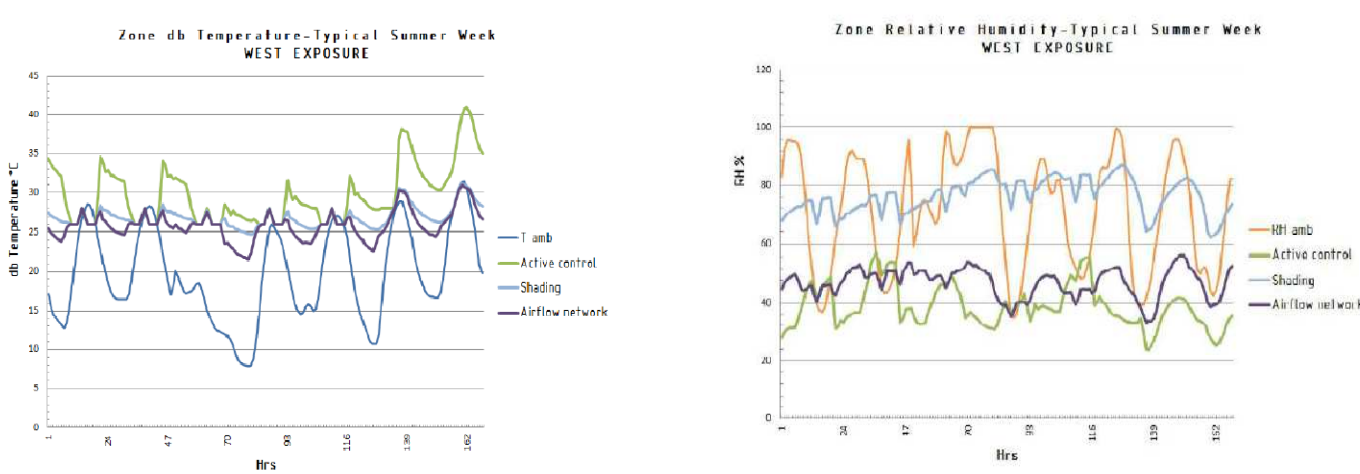

Fig. 11. Zone Dry bulb Temperature(a) and Relative Humidity(b) comparing three different strategies to reduce summer overheating.

CONCLUSIONS AND FURTHER RESEARCH

This research shows a methodology for evaluation of full scale building energy behaviour considering results obtained from monitoring activity and dynamic simulation. Simulation tools allow to investigate different scenarios to improve the building performance and comfort indoor.

An important aspect considered it has been the detail of the model simulation: in the case study it was decided to adopt "multi-zone" model to evaluate the environmental performance for a specific thermal zone and to extend results to the full scale the building . This approach offers the opportunity to verify the impact of a technological solution on the energy behaviour of a full scale building minimizing the complexity of the model simulation and consequently the possibility of making mistakes.

According to the results of model simulation of Department for Productive Activities, the main energy consumption is due to the new building (block 2). Considering the retrofit of building throught an improvement of thermal plant in order to reduce energy consumption, it is reasonable to introduce the active control for fan-coils only. In fact, installing an active control system on radiators of block 1 is much expensive because it is necessary to change the hydraulic connections on each unit to insert three-way valve. Considering the introduction of an active control in fan-coils of block 2, the estimated value of energy saving is about 25-35%. Installation cost for each room is 1100-1200 euro, and considering max 2 fan coils within a room, total cost would be about 40.000 euro. However, active control does not provide the solution to the problem of indoor discomfort due to the double glazing facades in office rooms located in block 2, especially in the summer period. In this case the the most cost-effective ways to improve building energy performance and comfort indoor is the building envelope retrofit through the investigation of different technological solutions for facades system.

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