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Actions to boost Energy Efficiency and Indoor Air Quality. Case studies in Italian schools

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1. Introduction

Indoor air quality in schools has always been receiving particular attention. [1] This is not only due to the health emergency ongoing all over the world. In fact, the last EU directive on energy performance of buildings[2] has recognized the relevance of the matter. In 2009 the World Health Organization guidelines highlighted that better performing buildings should provide higher comfort levels and wellbeing for their occupants in addition to improve health. However, also the behaviour of buildings' occupants is crucial. From this perspective, ENEA, *Italian National Agency for new Technologies, Energy and Economic Sustainable Development*, has been carried out a series of actions in order to promote both energy savings and the need and usefulness of achieving ever higher levels of air quality in shared environments. The experimental awareness campaign we present was carried on in several schools. It focused on an active involvement of students, especially in terms of direct and collective processing and interpreting the results (data) recorded through the aid of an ad hoc instrumentation provided, thus allowing the participants to visualize the outputs of their behaviour. Starting from the idea of a *practical* sharing of these actions [3],

hopefully new habits and robust pro-environmental knowledge will be acquired, replicated and disseminated over time even outside school; thus establishing a sort of *virality*, a beneficial "wildfire" contagion of the project experience towards other contexts and subjects.[4] The possibility by the students to become a sort of "multiplier subjects", is therefore, in this case as in other Behaviour Change projects, one of the aims of the implemented initiative.

2. Background, History, Review-of Literature, or Methodology

In the framework of EFFEDIL project [5], ENEA decided to evaluate a monitoring strategy of the indoor air quality in a low secondary school in the South of Italy, where an energy retrofitting programme was undertaken. The indoor air pollution in schools is a combined effect due to both indoor and outdoor physical, chemical and biological factors, and it also depends on environmental ventilation level. By monitoring public infrastructures, the so-called "sick building syndrome" has been shown to be responsible for diseases, such as allergies and headaches [6] [7] [8]. ENEA set up a methodology for continuous and real time monitoring in order to evaluate comfort and indoor air quality, in collaboration with the ISS – *Istituto Superiore di Sanità*, which developed the guidelines concerning the passive air quality[9]. Then, an experimental campaign *in situ* was conducted, by means of a sensor network specifically designed for the measurement of temperature, humidity, CO2, NOx, CO, VOCs. The basic idea aimed at involving students, after a training period and an awareness campaign on energy efficiency aspects.

3. Results and Findings

Micro-climatic parameters were monitored, together with temperature, humidity and CO2, which are often in the cause of decreasing attention and learning in classroom. Through the training path on specific topics and by compiling daily tracking records, the reported information were used to synchronize all the data recorded through the sensor network. The initial evaluations show, for instance, how the CO2 values are strongly linked to some specific activities in the classroom and dependent on correct or wrong air exchanges. The study has shown that an aware management of the ventilation, during all the seasons, can maintain the CO2 values below 1000ppm, and thanks to other microclimatic factors, such as Temperature and Humidity, an adequate comfort level can be guaranteed. Other indicators of the indoor air quality were also monitored, such as CO, NOx and VOCs

Discussions and Conclusions

From a perspective focused on the achievement of a behavioural change by the subjects involved in the project (students), a goal that seems to have been essentially reached thanks to the estimates of the air quality made over time (pre-post intervention

measurement), the *feedback* played by these estimates proved crucial. In literature, the *feedback* tool (in its various and different application forms) is recognized as one of the most effective strategic levers (*drivers*) for achieving and consolidating new behavioural habits experienced during the project phase. It is also desirable, as a phase to be planned in subsequent moments, the opportunity to implement a *feedback* system for a more or less long post-intervention period. Moreover, this time frame would allow to build more rigorous measurements from a scientific point of view to test the validity of the strategy used, organizing comparisons between experimental and control groups through *randomized control trials* (RCT) [11] .

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