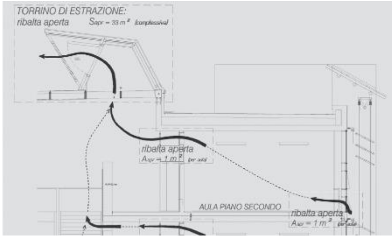
ITA_ Imola_High School “L. Orsini”

Image 01: South external view
© *M.Grosso, A.DelFiume*

Image 02: interior view - atrium
© *M.Grosso, A.DelFiume*

Image 03: *Natural ventilation scheme*
© *M.Grosso*



Building Specifications

Address	Via Vivaldi 76, 40026 Imola, Italy
Building Category	Educational
Year of Construction	2008
Special Qualities	Since the building-programming phase the building was conceived to be very sustainable connecting together different systems (natural, mechanical, hybrid) and strategies to assure energy efficiency. Night cooling and hybrid ground cooled air ventilation are installed and coupled with an absorption solar cooling system. Furthermore, solarwall®, ground heating and high insulation layers reduce the winter consumption.
Location	44° 21’ northern latitude, 11° 43’ eastern longitude, 47m above the sea level, located in a flat area in the Pedagna district in Imola. Imola is a town with a population of above 70.000. The Orsini school is located in an open area devoted to park activities and next to another school building.
Climate	Cfa (warm temperate, fully humid, hot summer) According to the Italian regulation, the winter climate zone is class E with 2.292 heating degree-days. The wind region is classified as zone 1 (av. daily velocity 1.6 m/s, wind prevalent direction from SW), the average summer temperature is 12°C and maximum temperature is 33°C.

Vent. Cooling Site Design Elements (Solar Site Design and Wind Exposure Design, Evaporative Effects from Plants or Water)

The school is composed by two principal bodies connected by a central atrium. The principal façade is facing south (SSW) to maximize the solar radiation and the daylighting. On the south boy are located the classrooms. Differently, the north facing body is devoted to offices, laboratories and other complementary services. The main façade is oriented to the principal wind direction (SW), while the central atrium acts as a good stack-driven extractor. A solar wall system is installed on the south façade in between the big windows, which are shadowed by external large seasonal oriented shadowing system made in metal blades (mechanically moved) and by integrated rolling blinds. A site analysis was developed using the site microclimate matrix method (based on wind and sun) to define the optimum positioning of the school building according to different activities (see Grosso 2011 and Chiesa&Grosso 2015). Natural materials and several renewable energy sources were integrated together and monitored.

Vent. Cooling Architectural Design Elements (Form, Morphology, Envelope, Construction & Material)

Italian school regulation require strict control of air exchanges, hence mechanical ventilation was installed to assure indoor air quality and energy comfort, nevertheless a natural ventilation system was also designed to allow night cooling. Furthermore a pre-cooled diurnal hybrid ventilation is assured by earth-to-air heat exchangers connected with the Air Handling Units. The building was simulated in both TRNSYS+COMIS and FLUENT CFD for analyzing the effect of night cooling and dimensioning the system. The simulated energy saving by the night cooling ventilative system for the classrooms of the ground floor is 59%, 57% for the second floor and 42% for the third (Grosso 2011). An integrated lighting and air-distribution system was designed after CFD analysis to reduce the influence of any suspended elements on the natural night flow passing though the classes. Furthermore, no suspended ceiling was installed because of the need to maximize the area of the exposed massive elements to increase the effect of night ventilation. The classrooms' ceilings have exposed concrete surfaces. A reduction in VOC emissions is assured by the use of natural materials and finishing.

Vent. Cooling Technical Components (Airflow Guiding Components, Airflow Enhancing Components, Passive Cooling Components)

The night cooling system is based on air-vents located in the lower part of the external-facing walls of the classrooms. These air-vents are automatically opened by temperature sensors. Furthermore, the classrooms are connected to the central atrium by other air-vents localized on the upper part of the confining wall (opposite to the inlet façade). The airflow is stack-inducted by the difference of temperatures registered in the atrium (3-storey space) and exhausted by small towers localized on the atrium roof (See Image 05.) The flow was simulated in CFD in order to dimension the air-vents and the positioning of these openings on different floors assuring that also on the last floor – where the difference in elevation between inlet and outlet openings is the smallest– a sufficient airflow is achieved.

Image 04: *inlet airvents* - © G.Chiesa

Image 05: *air extractors* - © G.Chiesa

Actuators, Sensors and Control Strategies

The night cooling system is automatically controlled according to the outlet air temperature in summer (opening of the external grid in the classrooms) around a 26°C upper limit. Furthermore, the extractors on the atrium roof are connected to rain sensors to prevent water penetration. The air-vents between the classrooms and the atrium consider the difference in temperature between these two spaces. During the monitoring phase, a lesson was learned: the use of an external temperature sensor can, in some specific cases, reduce the effect of the system by closing airvents even when the outdoor temperature is below the internal one. Moreover, in cases where the outlet value is around the threshold, the delay between two control cycles (sensor reading and actuator control) was increased in order to prevent On/Off actuating cycles quicker than the time needed by linear actuators to completely open the air-vents.

Building Energy Systems (Heating, Ventilation, Cooling, Electricity)

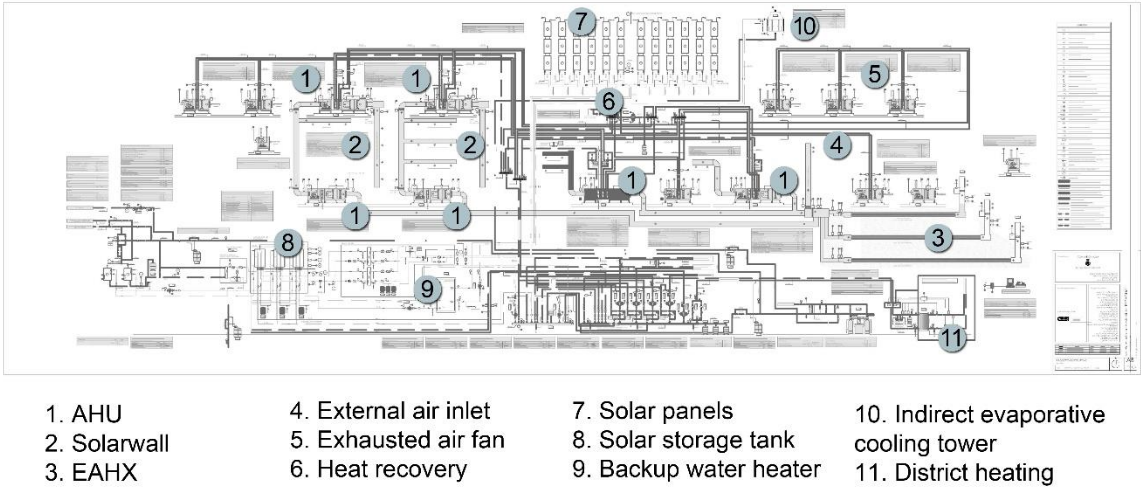


Image 06: *Overview of the systems' scheme* - © G.Chiesa, *M.Grosso*

The building comfort is both controlled by the use of Air Handling Units connected in winter to both a Solarwall® pre-heating system and an Earth-to-air heat exchanger –EAHX– (the biggest of its kind in Italy), and by the use of passive/hybrid systems in summer. In particular, night ventilative cooling is used together with diurnal EAHX pre-cooled hybrid ventilation, and a pavement cooling system based on an absorption system integrated with solar collectors. Lighting sources are connected with motion sensors and regulated according to the natural lighting to reduce energy consumptions. The EAXH system is composed by three fields for a total of 22 tubes of 70 meter. The system was dimensioned by using GAEA and furthermore was monitored for more than 30 months. The building is classified Casa Clima A+.

Building Ownership and Building Facility Management Structures

Ownership: Public – City of Imola

Architect: project leader arch. A.Del Fiume, procedure responsible arch. A.Contavalli, environmental consultant prof. arch. M.Grosso, arch. L.Raimondo, eng. M.Simonetti, Technical building system Meter&Saggese Engineering Srl, Companies CESI, CEFLA Impianti

Acknowledgements

n/a

Datasheet Source:

- Chiesa G., Grosso M. (2015a), "Accessibilità e qualità ambientale del paesaggio urbano. La matrice microclimatica di sito come strumento di progetto", *Ri-Vista*, vol. 01/2015: 78-91, Firenze University Press.
- Chiesa G., Grosso M. (2015b), "Sustainable school buildings: design management monitoring results and weaknesses. The case study of the High School "L. Orsini", Imola", *Techné*, vol. 09: 247-255.
- Chiesa, G., Simonetti, M. and Grosso, M. (2014), "A 3field earth-heat exchange system for a school building in Imola, Italy: Monitoring results", Renewable Energy, vol. 62, pp. 563-570.
- Grosso M. (2011), *Il raffrescamento passivo degli edifici*, 3rd ed., Maggioli, Rimini.
- Dal Fiume, A., Grosso, M. and Raimondo, L. (2009), "Una scuola sostenibile a Imola", Il progetto sostenibile_dossier, vol. 7, No. 21, pp. I-VIII.

Politecnico di Torino, Department of Architecture and Design.