VULNERABILITY ASSESSMENT - ITALY

Based on local, regional, national and international studies, surveys and field campaigns

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Index

A. Abstract

In Italy, children and students spend most of their active time in school buildings, approximately between 4 and 8 hours a day. It is estimated that 14-15% of the population, about 10 million people including students and teachers, are working every day in 40.000 public buildings throughout the national territory. Many health-hygiene and indoor air quality issues, attributable to environmental problems, are detected in most of the Italian scholastic structures. Relevant researches, often linked to European projects carried out in the last 15-20 years, have shown that indoor air pollution, along with the micro-climatic comfort, is a fundamental aspect for students' and workers' health, and especially for vulnerable groups such as children, adolescents and allergy sufferers (asthmatics).

The state of school buildings in Italy is various. A small number of school buildings were renovated through the years (windows, roofs, heating systems etc.) but most of them are still in need of interventions. At national and regional level, the legislation for indoor air quality is very old (1975) and it is more concentrated on sanitation aspects.

Italian government is carrying on a lot of activities for Italian school buildings, going through renovation, energy consumption and teaching standards. Minister of Health is supporting a lot of initiatives fostering indoor air quality (guidelines and projects) but there is a lack of new regulations. During the last decade a lot of entities (foundations, universities, ASLs – i.e. local health agencies) have developed European projects to monitor air quality inside schools buildings and find technical solutions to improve (SEARCH, INDOOR, SINPHONIE, HESE, INDEX and EXPAH) with significant results but the regulatory situation is not changed.

B. Analysis of Italian situation related to school buildings and air quality

B.1. Introduction and Reference legislation

Going into detail about primary (former elementary) and secondary (middle school) schools, according to the latest survey of ISTAT - National Statistics Institute – carried on in 2014, there are 16.995 primary schools with about 2.799.553 children enrolled and 8.045 secondary schools, enrolling 1.743.587 students. Total amount of this type of schools is 25.000.

In Piedmont Region, according to ISTAT and the school buildings registry of the Region (2014), there are about 1.364 primary schools attended by 191.399 children, and 561 secondary schools enrolling 117.997 children. In total, in Piedmont, regarding these two school levels, there are 1.925 schools. The city with more school buildings is Turin, which counts 223 complexes.

With such a significant consistency of school buildings and students who attend them, a lot of attention to health and medical aspects of indoor places must be taken into account and especially to the indoor air quality in general.

In Italy, unlike what happens about the atmospheric air, indoor air quality in public and private buildings is not regulated by actual legal regulations. The rules for the healthiness inside buildings shall be fixed for each municipality by the hygiene and health regulation.

However many provisions and directives deal with the indoor pollution problem, both at national and international level.

The Agreement of 27 September 2001 between the Minister of Health, Regions and Autonomous Provinces, about the document called “Guidelines for the protection and promotion of health in confined environments”, provided an analysis of key indoor pollutants and their effects on health and environmental comfort and established some general guidelines for the creation of a national prevention program. In the framework of this agreement, the “indoor” commission of the Ministry of Health drafted a new “guidelines-schema defining technical protocols for predictive maintenance on air conditioning systems”, since improper installation and maintenance can affect the quality of indoor air.

Regarding the limit values for indoor pollutants, there are no national standards; the only precautionary measure regarding formaldehyde is given in the Circular of the Ministry of Health of 22 June 1983 No. 57 “Use of formaldehyde - Risks related to the possible methods of use”, which reports a maximum exposure limit of 0,1 ppm (124 mg/m^3) in indoor spaces. In addition, the Ministerial Decree 10 October 2008 establishes provisions relating to the manufacture, import and marketing of wood-based panels and products manufactured with the containing formaldehyde, in order to ensure the protection of human health in their use in indoor environments.

For other substances, reference is made to the limits stated in the document published in 2010 by the WHO, "WHO guidelines for indoor air quality: selected pollutants", in which indoor and risks are defined.

Table 1. Main indoor air pollutants and their value limits according to WHO guidelines

Pollutants	Value limit (WHO Guidelines)
Benzene	17 µg/m^3 (for 1/10.000 maximum risk of lives)
CO	100 mg/m^3 - 15 minutes 35 mg/m^3 - 1 hour 10 mg/m^3 - 8 hours
Formaldehyde	0,1 mg/m^3 - 30 minutes average
Naphthalene	0,01 mg/m^3 - yearly average
NO_2	200 µg/m^3 - hourly average 40 µg/m^3 - yearly average
IPA	1,2 µg/m^3 (for 1/10.000 maximum risk of cancer)
Radon	400 Bq/m^3

The technical rules for the detection of indoor pollutants are:

- UNI EN ISO 16000-1: 2006: Air in confined environments - Part 1: General aspects of sampling strategy.
- UNI EN ISO 16000-2: 2006: Air in confined environments - Part 2: Sampling strategy for formaldehyde.
- UNI EN ISO 16000-5: 2007: Air in confined environments - Part 5: Sampling strategy for volatile organic compounds (VOC).
- UNI EN ISO 16000-7: 2008: Air in confined spaces - Part 7: Sampling strategy for determination of concentrations of asbestos fibers suspended in the air.
- UNI EN ISO 16000-9: 2006: Air in confined environments - Part 9: Determination of volatile organic compound emissions from building products and finishing products - Method in emission test chamber.
- UNI EN ISO 16000-10: 2006: Air in confined environments - Part 10: Determination of volatile organic compound emissions by 25 building products and finishing products - Method in emission test cell.
- UNI EN ISO 16000-11: 2006: Air in confined environments - Part 11: Determination of volatile organic compound emissions from building products and finishing products - Sampling, storage of samples and preparation of test specimens.

- UNI EN ISO 16000-12: 2008: Air in confined environments - Part 12: Sampling strategy for polychlorinated biphenyls (PCBs), polychlorinated benzo-p-dioxins (PCDDs), polychlorinated benzofurans (PCDF) and polycyclic aromatic hydrocarbons (PAHs).
- UNI EN ISO 16017-2: 2004: Air in closed, air and ambient air at the workplace - Sampling and analysis of volatile organic compounds.
- UNI EN 13098: 2002 - Workplace atmospheres - Guidelines for measurement of airborne micro-organisms and endotoxins.
- UNI EN 15251: Criteria for the indoor environment for the design and assessment of energy performance of buildings, with regard to indoor air quality, thermal environment, lighting and acoustics.
- UNI EN 14412: Air quality in confined environments - Diffusive samplers for the determination of the concentration of gases and vapors - Guide for selection, use and maintenance.

In light of the premises, the main national and regional current regulations are reported below; they should guide the school buildings to reach environmental quality objectives.

National legislation

- Ministerial Decree 18 December 1975, Ministry of Public Works, "Norme tecniche aggiornate relative all'edilizia scolastica, ivi compresi gli indici minimi di funzionalità didattica, edilizia ed urbanistica da osservarsi nella esecuzione di opere" (Technical rules about school buildings, minimum indexes regarding construction and teaching functionality, to be applied in the works execution);
- Law 11 January 1996, n. 23 "Norme per l'edilizia scolastica" (School building rules).

Regional legislation (Piedmont)

- Regional Law n. 28 of 2007 "Norme sull'istruzione, il diritto allo studio e la libera scelta educativa" (Regulations about education, right to education and freedom of educational choice);
- Piano triennale di interventi in materia di istruzione, diritto allo studio e libera scelta educativa per gli anni 2012-2014 (Three-year action plan on education, right to education and freedom of educational choice, 2012-2014).

The first law on school buildings dates back to 1975. Its primary objective is the resolution of the serious situation of deterioration and inadequacy of schools structures, abandoned after Italy unification. The most significant credit about technical regulations, still in force today, was improving the standard of Italian schools to levels comparable to European ones, but still with many gaps.

In detail, the Ministerial Decree of 1975 takes into account sanitation criteria in the determination of the surface/child of classrooms, the individual air space requirements (CO_2 limit breathed relationship indoor/outdoor CO_2), the number of air changes, temperature and humidity limits. It concludes that, in order to meet sanitary criteria, the minimum area per child in primary schools and kindergartens is 1,80 square meters. A summary table (Table 2), taken from the text of the law, is reported.

Table 2. DM 1975 - Main indicators per type of school

Indicators	Primary	Secondary	High school
Classroom area (sqm)	153-167	201-275	166-301
Area per child (sqm)	6,11-6,68	8,06-11,02	6,65-12,28
Height (classroom, offices)	3	3	3
Height (gym)	5,4	7,5	7,5
Minimum area for school building construction (sqm)	2.295-12.550	4.050-12.600	6.620-33.900
Area per child in classroom (sqm)	1,8	1,8	1,96
Children number per class (DM 1975)	25	25	25
Persons number per class (fire prevention rules, maximum capacity)	26	26	26
Green areas (% of total area)	66,6%	66,6%	66,6%
Temperature /humidity	20°C + 2°C / 45-55%	20°C + 2°C / 45-55%	20°C + 2°C / 45-55%

The decree was repealed by the 1996 Law, but it was substantially included the new law, and present a number of significant shortcomings:

- Temperature and humidity fixed only for the winter season;
- Lack of air velocity and average radiant temperature of the surfaces;
- Effects of moisture on health;
- Natural air changes, enforced and monitored.

Essentially the sanitary aspects and the limit values such as temperature and humidity of 1975 are still in force.

National policies

In recent years, governments carried on interesting proposals about national policies, in parallel with the rules.

The *General Plan on School buildings* was confirmed as one of the priorities of the first period of government Renzi (2014). The great national plan called #scuolebelle is characterized by a program of small maintenance interventions to restore and maintain the functionality and decorum of school buildings, for an amount of 150 million euro (in 2014). These interventions affected 7.801 school buildings during 2014. Another 300 million euro were released in 2015 and covered 10.160 school complexes. The school building overall plan is made of two sectors: #scuolesicure, with interventions in the field of safety

measures, asbestos and barriers removal (2.865 interventions) and #scuolenuove (404 school buildings to be constructed). The total investment, according to data issued by the government, is expected to exceed 1 billion euro.

The need to implement such a strategy is certainly dictated by the difficult situation for school buildings in the country: "About 60% of Italian school buildings, as reported by "Ecosistema scuola" dossier edited by Legambiente, was built before the adoption of seismic standards and consume about 1.3 billion Euros a year for energy supply, while the energy costs for public buildings is estimated in more than 5 billion euro per year (according to Consip, which is the head office of purchases of Italian public administration).

By 2016 a three-year period of big investments ended: around 7 billion euro were set aside for a total of 27.721 started projects. The redevelopment proceeds too slowly, however, especially regarding the works of seismic and energy adapting.

B.2. Types of school buildings (national level)

The picture emerging from the annual reports about the conditions of the school buildings (such as the already mentioned Legambiente and Cittadinanzattiva - "Ecosistema scuola") and the data resulting from the National School Buildings Registry (law n.23/1996) by the Ministry of Education, outlines a hygiene and safety related situation which is still far from the regulatory parameters relating to safety and health in the workplaces.

The school building stock is composed of about 45.000 schools, characterized by buildings with a very high average age, in several regions; furthermore, many buildings were made before the adoption of technical rules on school building (Ministerial Decree 18 February 1975) and measures for buildings with special requirements for seismic zones (Law n.64/1974). To this structural condition of the assets it must be also added the delay in the adoption of legal requirements relating to fire prevention and safety of operators and users and many issues related to resource consumption, to the wellbeing of the indoor environment, to the management of the interested bodies.

Depending on types of schools (primary, secondary, kindergartens) we usually have different types of buildings, both for construction mode and for size and inclusion in the urban context, different ways of building use, different levels of crowding of environments and different types of plants. Furthermore, it is evident that increasing the school grade generally also increases the size of the buildings, the number of users, the degree of crowding of classrooms, the amount of space dedicated to use accessories (offices, sports activities, canteen services etc.).

The different building types are generated by different and possible architectural configurations based on the ratio between the classroom and the spaces of the school structure, or from the main distribution models: the "corridor" and the "functional unit". The next section describes the main types of buildings that can be found within the Italian school building stock:

Block school

This type has been a model for a long time in school building: it derives from the development of the "corridor scheme", through which a system of several adjacent classrooms is made using linear connections. In this conformation the building is directly in contact with the urban environment. Its dimensions don't differ from the surrounding urban fabric and is distinguished by austere and formal look. Teaching rooms are generally distributed and positioned towards the main access road, while the connecting corridor is on the back. The size of the classrooms ranges between 55 to 80 square meters with a height between 4 and 4.50 m. Other configurations derive from this type: "spliced block", aggregation of multiple blocks, generally with a "C" diagram, which generate a more complex articulation of volumes while maintaining a rigid and readable characterization; "internal empty block", a locking configuration with an internal courtyard.

Griddle school

Type characterized by a main body from which a lot of branches connect the various spaces dedicated to educational activities of the school, distributed by both corridor type or functional unit type. The griddle school has a volumetric system similar to the block school, even if with lower heights, but with a plane extension similar to extended school structure. Generally they have one or two floors, so the planar development gives considerable size to the building. The lighting of most indoor environments occurs through windows placed on the cover/roof. Precisely because of lighting problems of the environments, the building type evolved into more complex type such as "plate with empty inside".

Extended school

The extended school develops through a dilation of the spaces to the outside, in opposition to the block type, with a distribution linked to the "functional unit model". This type is greatly different from the rationalist school model, introducing concepts such as repeatability of base nucleus and identifying new functional spaces, pointing to a progressive growth of the building over time, in relation to the changing in pedagogical or demographic needs.

Open plan

This configuration shows an extreme typological flexibility that was developed during the Sixties and Seventies. It is placed in an intermediate position between the block-diagram with a corridor distribution and the scheme for functional unit. It presents an open floor plan; there isn't a hierarchical sequence of classrooms, but the space is organized according to different sizes and destined in different activities through the use of internal mobile partitions which allow to obtain articulable environments or large spaces.

Street school

The idea of the school as "street" was also born in the Sixties and Seventies: a body open to the surrounding environment, which favors social relations; main accesses and hierarchies between spaces disappear, so that school, now projected outside of its

traditional isolation, reproduces the characteristics of the city and becomes itself an urban fact.

B.3. State of conservation of school buildings (national level)

B.3.1. School buildings age

- 6,50% was built before 1900;
- 14,79% was built between 1900 and 1940;
- 43,74% was built between 1941 and 1974;
- 27,85% was built between 1975 and 1990;
- 7,12% was built between 1991 and 2012.

B.3.2. School buildings previous use

Besides knowing the year of building construction, it's relevant to investigate whether it was subject of recent maintenance work: any regulation may have led to adaptations of buildings; for example, interventions made by the fact that the building was born with other purposes and then used as a school. In Italy the buildings currently hosting schools were originally:

- 87,44% schools;
- 6,60% historic buildings;
- 4,78% housing;
- 0,11% barracks;
- 1,08% other use.

In addition, the year of construction of the buildings is associated with the structural deficit of them: in fact, many of the existing schools are built without the static suitability and with a seismic safety level not aligned to current standards, set out today in the technical standards for construction issued by the Ministry of Infrastructure with Ministerial Decree 14 January 2008. Assessing the construction periods, it's possible to find almost all the construction techniques: traditional construction, mixed structures with bearing walls and floors of reinforced concrete, reinforced concrete structures on site or prefabricated, steel structures. The safety of the facilities, a good livability of the school environment, the suitability of the equipment and furniture are essential to ensure the smooth running of teaching and administrative activities.

B.3.3. State of the facilities and other features

- 10,14% is built according to seismic criteria;
- 56,05% has the static suitability certificate;
- 57,74% has a certificate of viability;
- 69,79% owns the sanitation certificate;
- 35,41% has the fire prevention certificate;
- 51,82% has fire escapes;
- 90,07% has panic doors;

- 95,07% carried out evacuation drills;
- 14,37% addressed interventions for eliminating architectural barriers;
- 74,27% has green areas and gardens;
- 55,11% has gyms;
- 23,07% has a kitchen inside.

From a survey carried out by the Ministry of Education on the implementation of Legislative Decree no. 626/1994, on a sample of 9.590 schools, it is clear that the situation of schools is still far from the regulatory parameters relating to safety and health in the workplace. But thanks to a careful verification, there was an increase of static usability certifications of buildings and sanitary-usability certifications, as well as an enhancement of the culture of exercises for safety (evacuation tests). Many schools, however, still need urgent maintenance.

The existing school stock is a much larger share than new construction school and, as noted, is responsible for the majority of energy consumption. The data shows that the newly built schools meet, for the most part, all the sustainability and resource-saving requirements, but the same cannot be said about the existing buildings. Italians school buildings dating back to years 1950-1980 have been built without any rule on savings; those built in the period from the eighties to the present day have been made according to the criteria defined by the law n.373/1976, which nowadays are completely unsatisfactory. With the enactment of Law n.10/1991 schools, like all new public buildings or building renovations, would have to integrate energy saving measures and renewable systems for public interest, but the application of the rule in the whole national territory has led to a school building stock with a lower standard of quality than the European average. Some studies, conducted in buildings taken as a sample, also state that the total energy consumption of the Italian schools has a share of 77% for heating and 23% for electricity. The average consumption of primary energy relative to the winter heating of a school building is about 290 kWh/sqm per year, while the average electricity demand for lighting is about 70 kWh/sqm per year. The confirmation of these values stays in the building structure: the low average transmittance of the building structure is about 1,25 W/(m² K) and the types of equipment installed shows a poor performance.

Innovative policies in energy sector:

- 63,9% of the buildings use energy-efficient sources for lighting;
- 24,4% use other forms of energy saving, such as the use of thermostatic valves, compensated control instruments, photoelectric cells etc;
- 8,2% use renewable energy sources (photovoltaic systems and solar thermal panels etc.).

B.3.4. School building management

- 36,1% of the buildings need urgent maintenance interventions;
- 56,0% of the buildings suffered in the last five years of extraordinary maintenance.
- The average investment for maintenance is € 40.961 for extraordinary maintenance (average cost for each building).

B.4. Air quality data (city/region)

Environmental data, collected in the last decade by measuring stations operating in the Piedmont Region and managed by ARPA Piemonte (Regional Agency for the Protection of Environment, which is responsible for the official environmental monitoring in the whole regional territory), show an overall trend towards improvements in air quality, net of annual weather variability, but still underline the critical difficulty of the territory, in particular the urban area of Turin (the city is located in a valley protected from winds due to the presence of the Alps) in respecting limits and target values for the protection of human health.

In 2015, only 5 of 12 pollutants measured by ARPA exceeded the respective limit values throughout the regional territory. PM_{10} exceeds the annual limit value in 17% of the measuring points, particularly those characterized by intense traffic; the daily limit is exceeded in 67% of the stations. Compliance with the annual limit value is observed only in rural areas and in valleys contexts. $PM_{2.5}$ exceeds the limit value in 65% of monitoring stations, mainly located in lowland areas with discrete levels of human activity. The situation has worsened compared to 2014, the annual limit value of 25 $\mu g/m^3$ exceeded in 5 monitoring stations on 8, while in 2014 had been exceeded in one station.

Nitrogen dioxide (NO_2) exceeds the annual limit value in 32% of the stations measuring it, in particular those operating in the urban area of Turin; the hourly limit is respected everywhere except in the traffic station of Turin-Rebaudengo. Benzene has exceeded the target value in 27% of measuring sites. The highest values are found in sites from the Turin urban area. There has been a general increase compared to previous years. Ozone (O_3) confirms its criticality in the summer months throughout the study area. The target value for the protection of health was exceeded in 92% of the measurement points. Overall, the higher values of the pollutants (PM_{10} concentration, $PM_{2.5}$ and NO_2) are found in the urban area of Turin, although O_3 has higher concentrations in rural and mountain areas.

The year 2015 shows a worsening trend compared to 2014, which is believed to be primarily due to particularly unfavorable dispersion conditions in winter months.

Table 3 shows the data collected by ARPA Piemonte, referring to annual averages of the main pollutants recorded by all regional station for the last five years available.

Table 3. Annual averages of the main pollutants recorded by ARPA Piemonte monitoring stations, 2011-2015.

Year	PM_{10} [µg/m^3]	$PM_{2,5}$ [µg/m^3]	NO_2 [µg/m^3]	O_3 [days per year]	Benzene [µg/m^3]
2015	30,5	21	22	56	1,5
2014	28,5	16	29	21	1,3
2013	31,5	19,6	32	48	1,3
2012	35	21,6	35	63	1,5
2011	36,5	21	38	71	2,1

Insight: City of Turin

Turin is located in the most industrialized area of Italy and among the most industrialized in Europe. The pollutant emissions are therefore particularly high. Furthermore, the river Po valley is characterized by a morphological conformation that makes difficult the dispersion of pollutants. Nevertheless, the air quality in Turin has improved significantly over the past 30 years.

Since the 70's, policies for the reduction of chemical agents dispersed in the air have been adopted. These policies have yielded good results, allowing significant reductions in the concentration of sulfur dioxide (SO_2), benzene (C_6H_6) and carbon monoxide (CO). However, the objective and significant improvement in air quality is still not enough to meet the new limits introduced by European legislation to protect human health and the environment. Strong criticalities remain for: nitrogen dioxide (NO_2), ozone (O_3) and suspended fine particles (PM_{10}).

Regarding in particular PM_{10} and NO_2 should be noted that, despite a sharp decrease of these pollutants has been registered in the last 30 years, the European Union sets strict rules of the limits: for PM_{10} annual average must not exceed 40 µg/m^3 and 35 is the maximum number of exceedances of the daily average of 50 µg/m^3 allowed; for NO_2 annual average should not exceed 40 µg/m^3 and 18 is the maximum number of exceedances of the hourly limit value of 200 µg/m^3 allowed. The pollution from PM_{10} and NO_2 represents the most heartfelt urgency, and the measures undertaken by Turin and other Italian cities are mainly concentrated on reducing them. In this regard, the traffic restriction measures adopted by the City of Turin contributed, in recent years, to a gradual reduction of pollutant concentrations in the air; nevertheless, as mentioned, such results remain insufficient. With regard to PM_{10}, for example, in 2015 the average values registered were lower by about 40% compared to 2006, and the number of exceedances of the limit value was also significantly decreased (-54% in 2015 compared to 2006). For nitrogen dioxide improvements have been registered in 2015 compared to 2006 (-31% of the average value).

Table 4 reports the data collected by Arpa Piemonte, referring to monthly averages of the main pollutants recorded by all regional station for the last year available (2016).

Table 4. Monthly averages of the main pollutants recorded by ARPA Piemonte monitoring stations, 2016

Date/Month	PM_{10} [µg/m^3]	NO_2 [µg/m^3]	CO [µg/m^3]	O_3 [µg/m^3]	SO_2 [µg/m^3]	Benzene [µg/m^3]
01_2016	57,8	98,9	2,7	31,3	5,9	5,3
02_2016	40,8	83,9	2,2	44,2	8,8	3,7
03_2016	32,6	87	2	64,4	7,7	2,9
04_2016	27	62,1	1,6	82,1	6,5	1,7
05_2016	17,8	64	1,4	67,2	5,9	1,5
06_2016	18	54,8	1,5	112,8	9	1,3
07_2016	21,4	61,6	1,4	150,3	9	1,2
08_2016	18,4	47,4	1,2	123,7	7,3	1,1
09_2016	26,6	82	1,3	118	8	1,5
10_2016	37	85,3	1,3	48	10,5	2,6
11_2016	49,2	88,4	1,6	30,3	13,3	3,7
12_2016	75	134,5	2,8	9,9	14,9	8
Average 2016	35,1	79,2	1,8	73,5	8,9	2,9

B.5. Indoor air quality data in school buildings

Poor indoor air quality (IAQ) has respiratory effects and other effects related to the health of the occupants. The IAQ affect the general well-being due to the possible presence of numerous specific pollutants with a wide variety of causes and sources. The problem has been reported on many occasions in the scientific literature and was mentioned in recent policy statements, guidelines on air quality and overall strategies of the IAQ management, as well as by political and organizational bodies that deal with health public and related environmental issues. Although there are no rules and regulations in Italy, many organizations, institutions and local health agencies (ASL) have conducted experiments and pilot projects on monitoring air quality in indoor environments (schools, offices, housing) in the last 10-12 years. The data reported in the tables relating to the "Data Collection", carried out in the framework of InAirQ project in WP_T2, refer to all of these experiences, mainly in European projects: SEARCH, INDOOR, SINPHONIE, HESE, INDEX and EXPAH. In them, many schools from different Italian regions were monitored, from north to south;

these cases bring reliable and consistent results which effectively represent the indoor air quality of Italian schools.

Table 5 provides the annual average of pollutants monitored in 44 schools in six different regions.

Table 5. Annual average of pollutants monitored in 44 schools in six different regions

Year	PM_{10} [µg/m^3]	NO_2 [µg/m^3]	Formaldehyde [µg/m^3]	Toluene [µg/m^3]	Ethylbenzene [µg/m^3]	Benzene [µg/m^3]	Xylene [µg/m^3]
2008	82	19	33,07	5,01	1,82	1,95	7,1

In order to investigate cases carried out in Piedmont Region, in particular near Turin, a case study of the SEARCH project, carried on in Venaria Reale is reported. Experts from Arpa Piemonte and ISPRA (Higher Institute for Environmental Protection and Research) have monitored the air quality in a secondary school, "Scuola media Don Milani", by measuring the following pollutants: PM_{10}, NO_2, Formaldehyde, Toluene, Ethylbenzene, Benzene, Xylene.

The results of the project show that this school has the worst performances of all schools involved in the project regarding the recorded PM_{10} levels (very high), indoor and outdoor. In general, Italy was in line with the other European countries of the project, except regard formaldehyde, which is very high compared to other foreign cases.

Table 6 shows the data relating to the monitoring phase in Don Milani school. Please refer to the prepared Excel file, compiled in the phase of Data Collection, as part of WP_T2 of InAirQ project.

Table 6. Results of the monitoring phase performed in school "Don Milani" in Venaria Reale, February 2008. Type of data: 5 days average

Classroom	PM_{10} [µg/m^3]	NO_2 [µg/m^3]	Formaldehyde [µg/m^3]	Toluene [µg/m^3]	Ethylbenzene [µg/m^3]	Benzene [µg/m^3]	Xylene [µg/m^3]
Artistic Lab	233	43,26	24,4	5,9	1,32	0,43	6,3
1D	136	38,01	6,0	4,4	0,82	1,82	3,2
1G	149	52,08	7,3	3,1	0,79	1,58	2,6
1A	-	31,92	7,5	4,4	0,82	1,82	3,1
1F	-	40,32	8,2	5,0	0,91	2,02	3,6
1B	-	36,12	9,1	5,5	1	2,24	3,9
1H	-	38,22	10,2	5,7	1	2,34	4,1
weighted average	142,5	41,67	8,07	4,71	0,95	1,98	3,4

B.6. Conclusions

In Italy the situation of school facilities shows all the difficulties and shortcomings of the lack of planning in the sector, although there are some excellent examples of school architectures. In addition to the resources, it remains one of the main problems to deal with in this country.

The regions that have historically big cities in the top positions of the rankings for the quality of services and school construction, like Piedmont, Tuscany and Emilia Romagna, are also those that have doubled and tripled funding than the national average of investments in the maintenance of school buildings. In fact, the difference between North and South is substantial in medium-routine maintenance investment, denoting a different political-administrative approach in the overall management of the school structures. Also in the north regions, there is a greater focus on routine maintenance, with an average investment of Municipalities double than in the south: about 12.000 euro for building in the north against the 4.900-5.000 € in the south. However, the positive trend that we find over the years regarding the adoption of practices related to energy saving is rather interesting, although it's still quite shy compared to the opportunities in the field: in four years, in fact, the schools using sources of energy efficient lighting have increased from 46,50% to more than 63% and the structures using energy from renewable sources has doubled from 4% up to over 8%.

About the specific case of the monitoring indoor air quality in schools, except some experience related to European projects and some research studies related to ASL (Local health companies), important addresses and constraints that must improve the current situation are not found in regulation/laws. In fact, there are no enforcement authorities at

national level responsible of monitoring air quality in schools, there are no standards to be met at regulatory level, there is no obligation to conduct monitoring campaigns. The only imposed ones are the safeguard levels for temperature and humidity in schools (Ministerial Decree 1975).

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3. "Ecosistema Scuola" - XVII Report on school building quality and services by Legambiente.
4. National Registry of school buildings.
5. Regional registry of school buildings – Regione Piemonte (http://www.regione.piemonte.it/istruzione/edilizia/anagrafe.htm)
6. Three-year action plan on education and freedom of educational choice – 2012-2014 (Regione Piemonte).
7. Arpa Piemonte – website (http://www.arpa.piemonte.gov.it/)

C. Appendix 1.

Questionnaire to review policies to ensure adequate indoor air quality in schools

1. **Is there an authority responsible for ensuring adequate indoor air quality (IAQ) in schools?**

☒ No

❑ Yes

Please specify the level of authority:

❑ National

❑ Sub-national (regional). Please specify regions which have such authorities

2. **Are there health based IAQ standards or guidelines (exposure limits) for chemical and biological pollutants for non-occupational settings in your country?**

☒ no

❑ yes

Please specify the type of policy:

- ❑ legally binding standards or regulations
- ❑ legally non-binding recommendations or regulations
- ❑ action plan or programme

Please specify the level of the policies

- ❑ international policy
- ❑ national policy
- ❑ subnational (regional) policy

Please specify chemicals which are covered by this policy

❑ formaldehyde (exposure limit, averaging time):

❑ benzene (exposure limit, averaging time):

❑ NO_2 (exposure limit, averaging time):

❑ carbon monoxide (CO) (exposure limit, averaging time):

❑ $PM_{2.5}$ (exposure limit, averaging time):

❑ other pollutants (Please list them with exposure limit, averaging time):

❑ biological agents (Please list them with exposure limit, averaging time):

3. **Is there a regular IAQ monitoring or surveillance to assess levels of chemical indoor air pollutants in schools?**

☒ no

❑ yes

Please specify the type of the policy under which the monitoring is conducted:

❑ legally binding standards or regulations

❑ legally non-binding standards or regulations

❑ action plan or programme

Please give the policy title, year of adaptation ……..……

Please provide information on how surveillance is conducted:

❑ Measurements are conducted in response to complaints about IAQ

❑ Regular monitoring of chemical indoor air pollutants is conducted in randomly selected schools

Please specify which pollutants are monitored

❑ formaldehyde

❑ NO_2

❑ benzene

❑ CO

❑ Other chemical pollutants. Please list them (e.g. PM_{10}; $PM_{2.5}$):

……..

4. **In the last 10 years was an IAQ monitoring campaign carried out in schools in your country, region in the frames of a scientific project (national or EC funded or other types?)**

❑ no

☒ yes

Please specify which pollutants have been monitored (Regional level)

☒ formaldehyde

☒ NO_2

☒ benzene

☒ CO

☒ Other chemical pollutants. Please list them (e.g., PM_{10}; $PM_{2.5}$):

Benzene, Toluene, Ethylbenzene, Xylene, PM10.

Please specify which pollutants have been monitored (National level)

☒ formaldehyde

☒ NO_2

☒ benzene

☒ CO

☒ Other chemical pollutants. Please list them (e.g., PM_{10}; $PM_{2.5}$):

Benzene, Toluene, Ethylbenzene, Xylene, PM10, PM2,5, CO2, O3

5. Is there a policy that sets requirements for indoor temperature in schools?

❑ no

☒ yes

Please specify the type of policy

☒ legally binding standards or regulations

❑ legally non-binding standards or regulations

❑ action plan or programme

Please specify the level of the policies

- ❑ international policy
- ☒ national policy
- ❑ subnational (regional) policy

Please enter the policy title, year of adoptation.

D.M. 18-12-1975, Ministero dei lavori pubblici - Norme tecniche aggiornate relative all'edilizia scolastica, ivi compresi gli indici minimi di funzionalità didattica, edilizia ed urbanistica da osservarsi nella esecuzione di opere

Please enter the minimum temperature **20°C** maximum temperature **22°C**

6. Is there a policy that specifies ventilation requirements for schools?

❑ no

☒ yes

Please specify the type of policy

❑ legally binding standards or regulations

☒ legally non-binding standards or regulations

❑ action plan or programme

Please specify the level of the policies

- ❑ international policy

☒ national policy

❑ Subnational (regional) policy

❑ Please enter the policy title, year of adaptation

D.M. 18-12-1975, Ministero dei lavori pubblici - Norme tecniche aggiornate relative all'edilizia scolastica, ivi compresi gli indici minimi di funzionalità didattica, edilizia ed urbanistica da osservarsi nella esecuzione di opere

Legge 11-1-1996, n. 23 - Norme per l'edilizia scolastica

Please mark the specific policy provisions:

☒ The policy sets the minimum ventilation rate. Please specify: **"14 cu.m/h of air per child"** Coefficient of air exchange = **2,5 (primary schools), 3,5 (secondary)**

☒ The policy sets the maximum allowable CO_2 level. Please specify: **concentration limit of CO2 in indoor spaces = 1x1000**

❑ The policy includes monitoring requirements : NO

7. **Is there a policy to prevent chemical contamination or to have physical separation or certain minimum distance between schools and major roads, refuelling stations, garages** and other facilities for motor vehicles?

☒ no (only descriptive/qualitative considerations in DM – 18-12-1975)

❑ yes

Please specify the type of policy

❑ legally binding standards or regulations

❑ legally non-binding standards or regulations

❑ action plan or programme

Please specify the level of the policies

❑ international policy

❑ national policy

❑ Subnational (regional) policy

❑ Please enter the policy title, year of adoption……

Please provide information on specific policy provisions

❑ The policy requires physical separation or specifies minimum distances between school and major roads, refuelling stations, garages and other facilities for motor vehicles

❑ The policy requires minimum distance between schools and factories/other emission sources of toxic chemicals (give the minimum distance:……)

8. **Is there a policy to prevent mould/dampness indoor in non-residential buildings?**

☒ no (only descriptive/qualitative considerations in DM – 18-12-1975)

❑ yes

Please specify the type of policy

❑ legally binding standards or regulations

❑ legally non-binding standards or regulations

❑ action plan or programme

Please specify the level of the policies

- ❑ international policy
- ❑ national policy
- ❑ subnational (regional) policy

Please enter the policy title, year of adoption……

Please provide information on specific policy provisions

- ❑ damp and mould conditions in non-residential buildings
- ❑ building construction
- ❑ heating, ventilation and air conditioning (HVAC)
- ❑ building maintenance and use
- ❑ other, please specify……