Guidelines For Energy Efficient School Buildings In The Mediterranean Region

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Introduction: Guidelines for Energy Efficient School Buildings in the Mediterranean

With the evaluation of proposed solutions concluded at the International Campus in Athens, it was then possible to create a common Action Plan including Energy strategies for the improvement of energy efficiency in school buildings in the Mediterranean region. From this, Guidelines for the Mediterranean schools and educational buildings were formulated. The guidelines are very useful as they include examples of potential strategies to reduce energy demand and suggest how to achieve energy saving, exploring financial issues, implementing the use of renewable technology elements and optimising comfort, daylighting design and air quality and ultimately achieving energy efficiency in public schools.
In this brochure the “Teenergy Schools Guidelines : The Decalogue for local administrators” and the “Concept Design Guidelines for the implementation of Sustainable Schools Projects in the Mediterranean” are presented by Prof. Arch. Marco Sala, Arch. Antonella Trombadore from ABITA and Arch. Rainer Toshikazu Winter Province of Lucca.

TEENERGY SCHOOLS, a programme co-financed by the Regional Development Fund of the European Union, targets the improvement of Energy Efficiency in Public School Buildings in the Mediterranean Area covering 5 different territories and 3 typical climate conditions referred to coast, mountains and plains. The Partnership is composed by 8 partners from the following 4 countries:
Italy: Province of Lucca (Lead Partner) ABITA international research center Florence, Province of Trapani, Regional Energy Agency of Sicily, Cyprus: Cyprus University of Technology, Greece: Prefecture of Athens, NKUA IASA University of Athens, Spain: Regional council of Granada.

The project aims at solving 2 common problems of the Mediterranean Area: The lack of energy saving benchmarks targeted specifically to South European climate conditions and the low energy efficiency of actual School Buildings, Teenergy Schools will set up an Action Plan and a Common Strategy aimed to reduce energy costs and consumptions in public secondary school buildings.

The international Partnership is actually collaborating in research and concept design regarding: energy saving techniques, employment of renewable energies, integration of innovative materials, improvement of heating systems, strategies for passive cooling. Teenergy Schools is elaborating a Benchmark Guide based on data from an Energy Audit, that each Partner will conduct in order to provide representative values permitting to compare each School Building’s actual energy performance throughout the Mediterranean Area. 12 Pilot projects will be developed following the indications of the Action Plan - **www.teenergy.eu**

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Teenergy Schools Guidelines : The Decalogue for local administrators

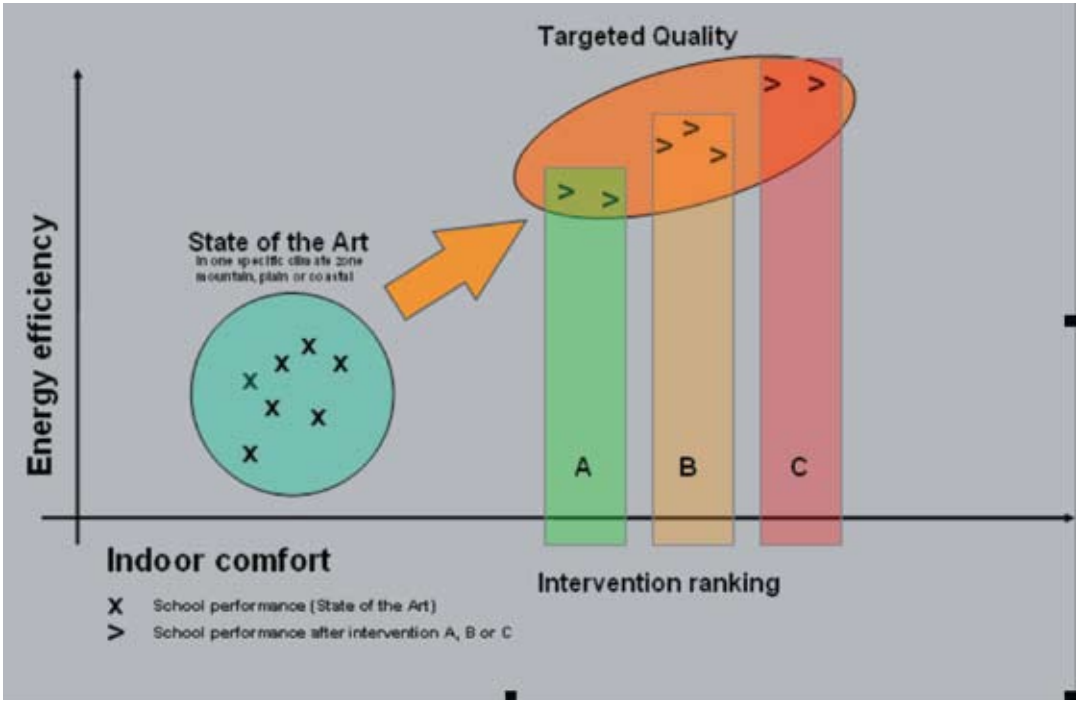
Prof. Arch. Marco Sala ABITA, Arch. Antonella Trombadore ABITA, Arch. Rainer Toshikazu Winter Province of Lucca

The added value of Teenergy Schools lays within its implementation of the process and the constant exchange of the common results - from the definition of the quality indicators to the elaboration of an adequate Energy Audit for the Partnership, the evaluation of the data mapping and benchmarking towards the elaboration of 12 innovative Pilot Projects. In fact, the project aims at providing the local administrators with useful decision support instrument to suggest a Best Path to follow in the retrofitting action and revitalization of existing school building, or what design criteria should be considered when a new school building is to be planned, targeting low energy consumption approach and sustainability awareness.

There is a need for effective tools helping the decision makers by combining scientific, normative and quantitative aspects such as energy efficiency, with human perception and subjective, qualitative aspects such as indoor comfort and psycho-physical wellness. And, above all, the Mediterranean context which represents the reference point for a new interpretation of a climate-adapted standard for sustainable building.

Teenergy Schools has developed a Decalogue to meet the needs for the providing a Common Method of decisional support involving stakeholders to fulfill the challenge of improving the school environment of education for the next generation of pupils, by starting today. The Teenergy Schools Decalogue aims at giving the basic indications for the implementation of existing schools retrofitting action a process. It is targeted to all the actors, but particularly to the public authorities—who must set themselves up as promoters of the process—and the scientific experts in charge with the coordination and the management of its application.

This Decalogue aims to illustrate the Best Path towards an appropriate energy efficient retrofitting of school buildings in the specific Mediterranean context, going beyond the usual isolated interventions and taking into account new aspects such as bio-climatic technologies: solar architecture, passive cooling, intelligent windows for natural ventilation, energy efficient facades including sun shading, cool or green roofs and the use of materials from natural local resources with positive LCA evaluation.



1. Setting the targets

Definition of the Quality objectives to be reached in the retrofitting of existing schools and for the construction of new school buildings aiming at energetic efficiency and good indoor climate in all seasons

- High Energy efficiency for heating and cooling
- Efficient natural and artificial lighting
- High standard of natural ventilation in classrooms guaranteeing low CO2 rate during the lessons ensuring good study conditions
- Use of sustainable building material based on critical LCA analysis
- Bioclimatic Strategies for energetic efficiency and good indoor climate in all seasons using Passive cooling (Ground Cooling/ Night Cooling) Sun shading and Natural Ventilation systems against Summer overheating
- Correct Use and management of renewable resources: use of appropriate, cost- and energy-efficient technology
- Acoustic quality inside the building for good audio comfort in the classrooms
- High Outdoor Environmental Quality (outside microclimate)
- Good visibility and media communication to guarantee wide spreading of results
- Didactical aspect of the intervention as added value of retrofitting / new construction for the active involvement of pupils (change of mindset/behavior) thermal bridges due to incorrect assembly of building components or the lacking of insulation.

Considering the actual energy consumption of the building, the overall project scenario, foresees the following improvements:

- High energy efficient external insulation with natural, hygroscopic materials avoiding heat losses and condensation
- Natural ventilation systems: New windows capable of giving high insulation standards and guaranteeing natural ventilation throughout “intelligent Window technique” for high thermal and hygroscopic indoor comfort
- Solar control using sunshading devices against glare and overheating in summer ensuring a good thermal-, air- and visual quality inside the classrooms
- Passive Cooling techniques: Night cooling throughout sensor-controlled openings during the summer.
- Control of natural and artificial lightning with LED based dimming technology.
- Innovative heating system based on low temperature radiation elements (floor or walls) and high energy efficiency boilers.
- Use of renewable energies (PV panels)
- Rainwater use in roof collectors for toilet flushing in a dual system avoiding electric energy for pressurization of water.

Conclusions

There is an increase of public awareness, of standards and regulations, of research and new technologiesand of European funding for Green Architecture. Common sense energy management is combined with energy production and energy efficiency, sustainability and well being.

WE ARE HEADING IN THE RIGHT DIRECTION!

Definition of the targeted improvements for the retrofitting of existing schools

2. Energy Audit

Checking the State of Art of the building and the energy performance of the envelope and energy consumption on HVAC (Heating, Ventilation and Air Conditioning) systems throughout data collection including bills, measurements and software simulations:

- Energetic behavior of the building taking into account the real consumption, the simulations (expressed in kwh/a m3)
- Thermographic anaylis for the detection of heat losses for efficient problem solving
- Analysis of the functionality, occupancy (pupils/m2), use and costs for the running of the building (euro/pupil/year)
- Evaluation of the Security norms
- Evaluation of Level of maintenance
- Structural characteristics, anti-seismic aspects
- Sanitary equipment

3. End user feed back questionnaire

- Analysis of the feedback of pupils and teachers throughout a specific (anonymous) Questionnaire in order to define the psycho-physical aspects regarding the actual perception of indoor comfort by the end users
- Involvement of the students and end user to improve their awareness
- Evaluation of indoor quality
- Comparison between assessed performances of the e school building, the monitored use and occupancy and the satisfaction of the end users of the building in order to obtain a critical view of the actual situation.

4. Mapping and Evaluation

- Analysis and mapping the results with the support of adequate tool for the homogenization of the data at an appro priated decision scale (Municipality context, Provincial/Regional/National/ International) and Analysis and graphical visualization of the collected data from the Energy Audit, the End User Feedback Interpretation and graphical visualization of the collected data from the Energy Audit and the End User Feedback
- Evaluation of the gap between State of Art and Target,
- Analysis of the critical point where the data of energy performances of the school buildings are below the average (Mapping and Positioning of the results in a larger context (regional, national, European) taking into account specific 3 climatic sub areas: Coast, mountain and plain.

5. Benchmarking in the context

- Comparison of the monitored school buildings to obtain a performance-ranking for the definition of preferences : which school building need to be refurbished first?
- Analysis throughout multi issue criteria: what are the main criteria?
- Definition of thresholds of energy performance, indoor quality level, available budget

Thermography showing the bad energy performances of existing single glazed window surfaces. A. Passaglia Artistic Institute, Lucca

6. Best Path Methodology

The Best Path Methodology aims at defining the most adapted solution in terms of economical technical and human aspects following the elaborated quality criteria as indicated above. On administrative and political level a critical weighting of the importance of each of the following four main objective must be considered:

A. energy efficiency
B. indoor comfort
C. quality of communication of the project,
D. technical aspects (for instance obligatory issues such as anti-seismic norms, fire-security, sanitary aspects)

Obviously each refurbishment or new construction of a school has an important mediatic value for the local administration, therefore the quality of the communication has to be considered an important issue. Building Sustainable Schools in the Mediterranean Area with bioclimatic principles in an energy efficient, socially and politically participated approach has a high value in terms of innovation.

Each one of these aspects will have a weight expressed in % following the strategic decisions of each single administration.

7. Interdisciplinary involvement in the Participated Planning Process

- involving all the stakeholders of the school environment: pupils, parents and teachers, driven by the initiative of the ad ministrational responsibles engaged in a transparent, participatory round table with the help of qualified technicians: the project bases for new schools or the refurbishment strategies for existing schools has to be elaborated in an interac tive and interdisciplinary process involving all parts, taking into account the above mentioned ranking of priorities fol lowing the Best Path integrating previous analysis such as Energy Audit and the End User Satisfaction.
- The continuous illustration and monitoring of the proceedings of the process with is of great importance to guarantee satisfaction of all interests.

8. Concept Design Implementation of Architectural Solutions / Retrofitting strategies

- The Concept Design Solutions will be based on sustainable, energy efficient building technologies taking into account bio-climatical aspects in order to respond adequately in each single micro-climate area.
- High Indoor comfort is targeted by improving thermal, acoustic and visual comfort in the classrooms
- at least three scenarios with low medium and high outputs proportioned to the dedicated investment will be elaborated

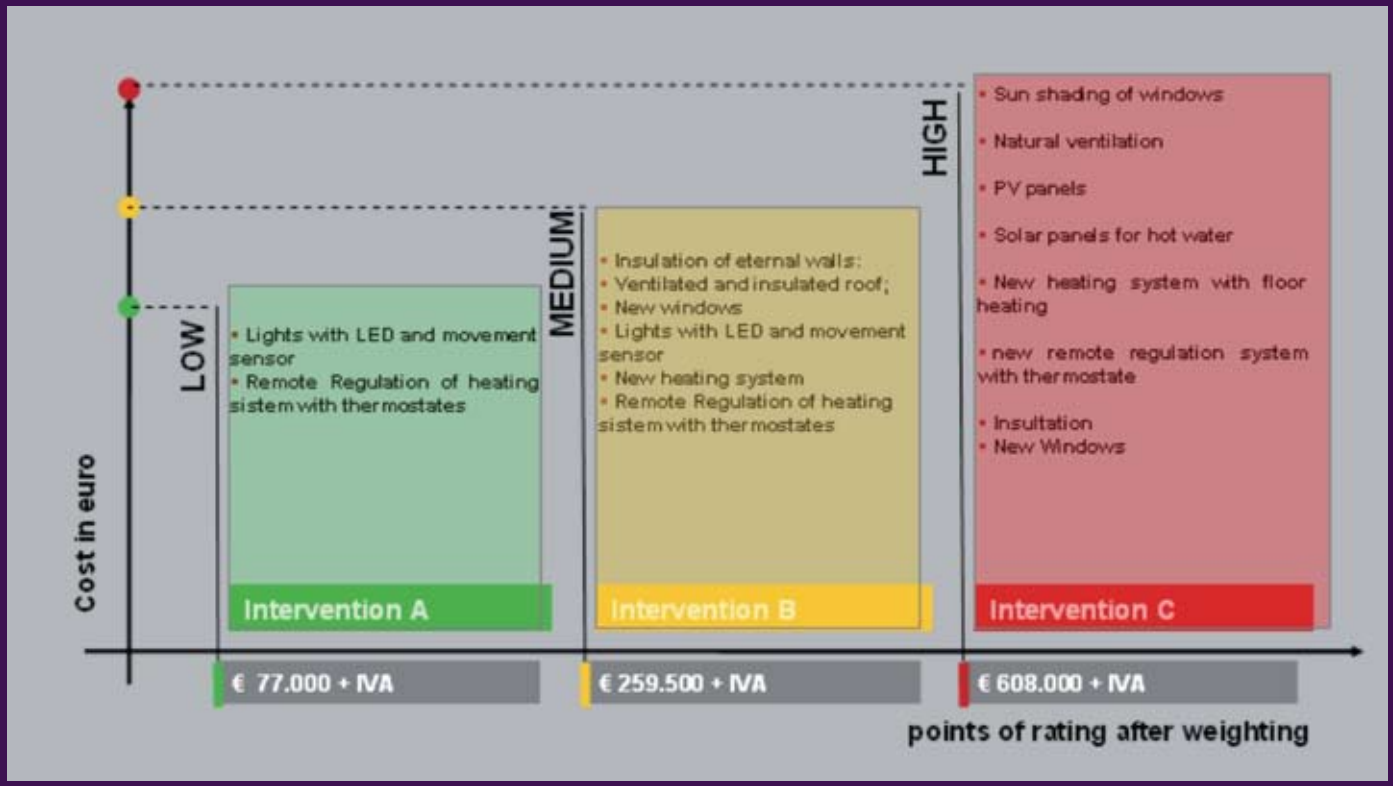
9. Cost benefit evaluation

- Critical choice of the most suitable solution in terms of energy efficiency, satisfaction of the end users, economic con text and communicational aspects for the local administrators political targets

10. Diffusion and Communication of the results: towards Best Practice

- Constant monitoring of the feedback within the participated process
- Promotion of the results within the context of a Pilot Project that has a didactical vocation
- Networking of similar experiences in order to promote wide speading of the initiatives and guarantee efficient research results in collaboration with scientific institutions and exponents of the building industry.

Model of definition of three levels of intervention following a cost benefit analysis



Concept Design Guidelines

for the implementation of Sustainable Schools Projects in the Mediterranean

Arch. Marco Sala ABITA, Arch. Antonella Trombadore ABITA, Arch. Rainer Toshikazu Winter Province of Lucca

A project for sustainable new school building or the retrofitting of schools in the Mediterranean Area must consider, as key element, the necessity of combining the research for a cost-effective insulation for the improvement of heating in the Winter period, with the Mediterranean climate –specific necessity of ensuring, during the Summer period passive cooling and a high ventilation rate to guarantee good indoor conditions. In fact, Secondary High schools are run until the end of June when temperatures have already risen substantially.

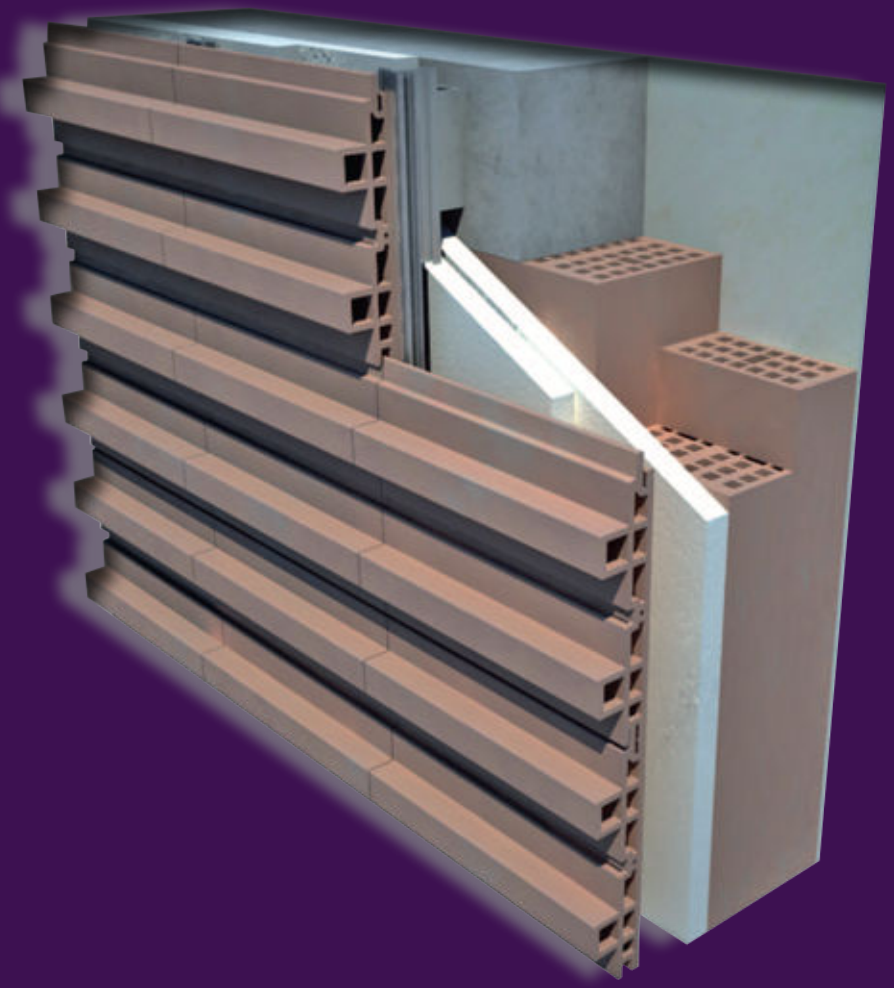
Mediterranean buildings are traditionally built on a simple thermal mass concept, which helps to reduce the great temperature differences during day/night in the Summer time. Reintroduce thermal mass in the modern school building is to be reconsidered as a simple, but very effective, non energy-intensive method to ensure comfort.

The experience of Teenergy Schools after having developed a Common Implementation Methodology , what pragmatic technical prescriptions can be given regarding energy efficiency in the Mediterranean school context? In the following pages a short Guidelines are presented to implement the Decalogue approach as a pragmatic technical indications to allow higher energy efficiency in the Mediterranean schools buildings.

Analyzing the appropriated Architectural Solution elaborated during the Concept Design of the 12 innovative Pilot Projects we should take advice about developing an energy strategy, designing and specifying the fabric, services and controls systems, as tangible results and feasible propositions developed with the Partnerships local administrators.

1. Planning criteria and Architectural Strategies to reduce energy consumptions and environmental impact in Mediterranean Schools

- Low-energy architectural solutions according to the traditional principles in Mediterranean area: creation of thermal mass and natural ventilation combined with Passive Cooling techniques and Sun shading to cope with high Summer temperatures
- Application of appropriate, bio-climatic technology following a critical cost-benefit analysis
- Solar architecture using glass surfaces and bow-windows facing south working with passive solar gains helping to abate energy consumption in the Winter time. (making sure that during the summertime correct sun shading and natural ventilation systems avoid overheating)
- Use of traditional and innovative materials possibly from natural, renewable resources



Innovation and natural materials: one of partner enterprises producing ventilated façade systems (Palagio Engeneering, partner of ABITARE MEDITERRANEO)

2. Materials and construction technologies

- Using life cycle integrated analysis (LCA) helps to define appropriate choices regarding the productive cycle of each single employed building material: In fact, selecting high quality materials based on natural renewable resources possibly of local origin contribute to abate incidence of transportation
- The use of some traditional materials such as bricks as one of the main protagonists of technical evolution in the recent years have given birth to innovative building components with high added value , compatible to the use in the Mediterranean Building such as:

a) high energy efficient hollow bricks combining insulation, thermal mass and anti-seismic characteristics in one material, suitable of being used in load bearing walls without reinforced concrete structure

b) brick elements for “ventilated facades” that help to reduce solar impact on the buildings’ outer shell creating a natural ventilation without energy consumption

c) innovative wood components allow compact, massive wood bearing elements for walls and ceilings, ideal for custom-tailored prefabrication (this technology has indeed many positive aspects but must be contextualized with some thermal mass in order to make it suitable for Mediterranean Architecture, otherwise Night Cooling systems for example lose their efficiency)

d) hydraulic lime mortar and plasters from naturally generated lime stone ensuring good structural characteristics and high hygroscocip capacities

e) new , good quality cements that reduce the CO2 emission in their production, containing also less industrial waste material

f) photo-catalytic external building elements such as tiles and plasters that absorb and eliminate the atmospheric pollution,

g) new insulating materials from natural origin such as: wood and other vegetal fiber, plain wool, kork that allow a reduction of the heat dispersion, up to 50%, increasing comfort because transpiring, permeable to the diffusion of vapour, fundamental criteria to avoid phenomena of moist and fungus creation indoor.

h) Green roofs (and so called cool roofs) ensure a significant abatement of overheating of the buildings upper outer shell

3. Architectural Integration of Renewable energy source

- integrated photovoltaic cells in semi-transparent glass surfaces,
- photovoltaic and thermal panels integrated in the façade
- use of local micro-wind generators and micro-turbines for the generation of electricity from renewable resources (after critical evaluation of wind incidence in the relevant area)
- co-generation energy and biofuel advanced systems
- energy recovery systems
- heat pumps with geothermal tubes

Passive Solar Energy Gains in Mediterranean context: Semi transparent photovoltaic elements in the Meyer Hospital in Florence Careggi Project: CSPE Firenze Arch. Paolo Felli. Energy consultancy MSA., Arch. Marco Sala

4. Advanced technologies for energy efficiency in buildings

- lighting systems using LED lamps, that allow the energy reduction up to 80%, integrated dimming systems measuring the natural light intensity
- low energy ventilation systems, based on cycles of absorption / recovery heat with the possibility of integration in in novative “intelligent window” technology
- hybrid intelligent systems of passive ventilation using ground cooling and night cooling
- efficient building’s energy management including sensors, thermostatic and light-intensity and movement sensors
- solar system with direct integration for high efficient air conditioning.

5. Advanced technologies for energy/water resource management

- integrated systems for water reuse, (rainwater retention and use for toilet flushings) local plant-purification systems,
- technologies to monitoring and purification/controlled exchange of the indoor air
- BEMS (Building Management System) and IT systems for the continuous monitoring and optimization of the indoor comfort related to the energy consumption

6. Direct Benefits of Sustainable Schools

The results of a sustainable energy efficient schools building are not only economical:

- A healthy, productive learning environment (daylight and good acoustics improves performance, fresh air ensures a better level of attention)
- More concentrated pupils and therefore better learning quality
- comfortable indoor temperatures increase occupant satisfaction
- improved school environment means improved teacher retention
- and, of course: economical advantages in running the school building mean fast pay-back period of the investment for the refurbishing or new construction

The measures illustrated in this short Guide can be applied when designing a new building as well as refurbishing existing ones. In the case of retrofitting action the Energy efficiency measures can often be incorporated at a marginal extra cost. Routine maintenance can also present opportunities for introducing energy efficiency measures. These measures have the advantage of not requiring capital investment, because they are financed out of the annual maintenance budget. Energy saving measures incorporated into maintenance work provide very good pay-back returns, some costing no more than the conventional solution.

From research to the built solution: example of technological innovation suitable for Mediterranean Architecture: “Polo Technologico” Province of Lucca, Responsible Arch. Francesca Lazzari, Province of Lucca. Consultancy Arch. Marco Sala
Arch. Rosa Romano PHd Thesis: “Smart Envelope - dynamic and innovative technologies for energy saving.”

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