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High Performance School Buildings in Portugal: A Life Cycle Perspective

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High performance school buildings in Portugal: a life cycle perspective

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In 2007 the Portuguese government launched a major school modernisation programme, and has taken steps to ensure the long-term sustainability of facilities. Projects now anticipate use by the broader community, allow for possible income-generating opportunities during the design phase and include custom-designed energy management systems.

In order to meet the challenge of an aging - and out of date - network of secondary school facilities, in 2007 the Portuguese government launched a major modernisation programme.[1] A specially created state-owned company, Parque Escolar (PE) has already completed 104 schools; 70 are work-in-progress and an additional 39 are under design or tender.

Parque Escolar is feeding lessons learned over the past few years into its reference material and practises so as to continually improve its projects and contribute to the overall development of Portuguese construction techniques. It is now focusing on how best to manage the life cycle of the 104 completed schools in order to achieve high performance levels. This paper sets out some of the practises which are being implemented to this end.

DESIGNING AND BUILDING

Given that sustainability[2] is the ultimate goal, PE has developed state-of-the-art briefing materials and manuals which set high standards and ensure that all stakeholders' needs are taken into account. As sustainability[3] depends upon the efficiency and quality of learning spaces, PE's design manuals and guidelines are provided to designers early in the process and these set the stage for all aspects of the programme. The strategy adopted by PE is based on a conceptual layout designed to reorganise and standardise the plans for new schools according to their specific functional and educational needs, but it also takes into account their use by the broader community.[1] In a drive to achieve durability and low maintenance costs, briefs promote energy-efficient solutions in relation to design and construction and include equipment specifications.

1. Heitor, T. (2007), School Modernization in Portugal. Towards a Sustainable Model of Intervention, *www.mss.gov.si/fileadmin/mss.gov.si/pageuploads/ANG/OECD_Conference/School_Modernization_Portugal_Heitor.pdf*.

2. Social, environmental and economic.

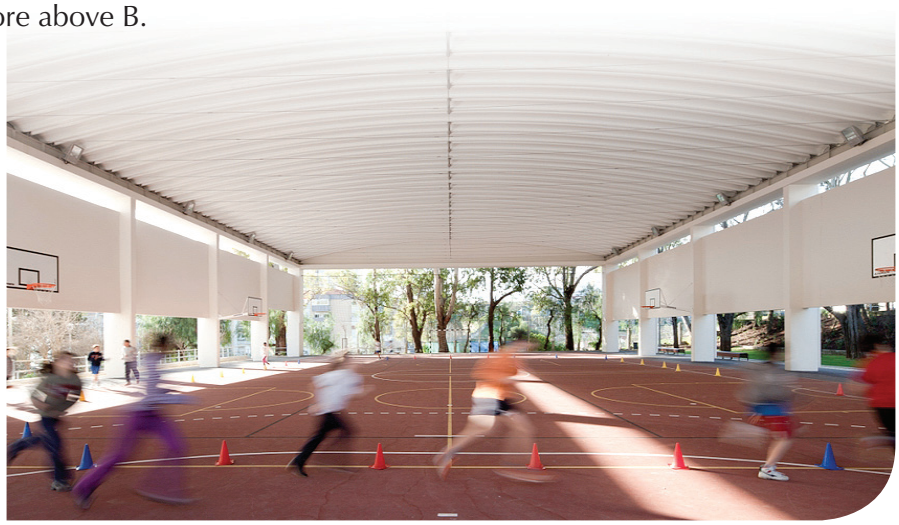
3. "Sustainable architecture extends beyond energy efficiency and green buildings. It incorporates the values of economic viability, social justice and ecological preservation in all stages of planning, design, construction and maintenance", summary of the international conference *"Sustainable School Buildings: From Concept to Reality", October 2009, Ljubljana, Slovenia*.

In order to improve certain regulations which had a negative impact on the energy performance of school facilities, PE worked alongside ADENE[4] to produce a set of requirements designed to generate energy savings, namely by lowering the reference comfort temperatures used in the design of air conditioning systems.

ENERGY PERFORMANCE RATINGS: EVALUATING DESIGN

Each project needs to follow PE's guidelines but also allow for individuality. But despite the difficulty of integrating all the various stakeholders' constraints and requirements into each set of plans, facilities have been able to achieve significant increases in energy efficiency. The average rating obtained for schools' energy performance certificates is B[5] for the design stage. This does not take account of the future installation of 100 kWp of photovoltaic solar panels in each school which will make them energy sufficient. Thanks to early planning, the reinforcement of existing roof areas – in order to accommodate the future photovoltaic installations – is included in the design stage and factored into construction time.

Another state programme[6] which equips schools with renewable energy systems such as solar panels and small wind turbines will enable schools' energy performance to rise to the highest rates in Portugal: A and A+. Note that the majority of buildings which are currently evaluated are rated under B-; only 5% of them score above B.



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Francisco Arruda Secondary School, Lisbon

Typical thermal insulation coefficients

	Reference: maximum value	Adopted value
Walls [W/m2ºC]	1.8	0.9
Roofs [W/m2ºC]	1.25	0.6
Floors [W/m2ºC]	1.65	1.2
Window glass	0.56	0.35

4. ADENE is the Portuguese Energy Agency.

5. The Portuguese rating system for energy and carbon emission efficiency uses grades 'A' to 'G'; an 'A' rating is the most efficient. This system takes into account both the quality of the building skin, as an insulator and protector of the internal environment quality, and consumption rates generated by the equipment which has been installed. Directive No. 2002/91/CE and prEN1517/2005 refer.

6. The "Green School" programme forms part of the national action plan for energy efficiency (PNAEE), *www.adene.pt/pt-pt/PNAEE/Paginas/welcome.aspx*.

These ratings illustrate the considerable care which has been taken in relation to building envelope design specifications, which reflect bioclimatic architectural principles. Furthermore, the ratings are the result of a significant investment in top-quality materials for insulation, windows and glass, roofing and shading devices, all of which present reference thermal characteristic values well below those required by Portuguese regulations. These ratings were only possible due to the combination, together with the low-consumption, of top energy-efficient systems and equipment.

OPERATION AND MAINTENANCE: AN EVOLUTIONAL PROCESS

With 104 schools in operation, PE set out to evaluate and measure the success of the modernisation programme. It also set out to measure the suitability of the concepts it is applying in terms of real operating conditions and costs; furthermore, the procedures guiding school communities need to be simultaneously optimised and harmonised, and equated to the new findings. Due to the strict energy efficiency criteria and the effectiveness of the passive measures implemented during the modernisation process, the outcomes illustrate a significant difference in relation to non-renovated schools which have less equipment and therefore lower energy costs.

Indeed, the need to create better conditions in school facilities, in terms of capacity as well as functionality and comfort,[7] has led to a greater recourse to systems. Renovated school facilities comprise not only larger surface areas but also new systems such as air conditioning, mechanical ventilation and security systems. They also have additional ICT equipment such as computers, interactive boards and wireless networks. Collectively, these generate higher energy consumption.

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Solar panels on the roof of Severin Faria Secondary School, Evora

7. Portuguese regulations regarding interior comfort are extremely demanding.

To help offset this factor, thermal solar panels have been widely installed in all school facilities. Designed to produce potable warm water, to be used both by school kitchens and sports premises, they have allowed for considerable savings on gas water heaters. Due to Portugal's mild climate, many schools now depend exclusively on solar panels for their warm water during half of the year.

In order to manage and monitor the newly installed systems, their behaviour and performances, each school has been supplied with a custom-made centralised management system. These systems are provided with simple interfaces and can be easily monitored by a non-professional. Information feeds into a database and integrates atmospheric data. It also adjusts lighting and air conditioning systems to school schedules.

By observing energy consumption and the systems' operational patterns, poor practices can be identified and corrected. A campaign is currently underway whereby systems are being adjusted to give higher efficiency levels and school users are sensitised to energy consumption. This, it is hoped, will reduce energy bills by nearly 30%.

Schools are being provided with maintenance teams which will take care of equipment throughout its life-cycle. As noted by the OECD, "The strategy of including long-term maintenance as a fundamental component of the project is critical to achieving the objectives of creating a sustainable education building stock that meets the long-term needs of education".[8]

Along with other actions designed to foster behaviour change in favour of sustainability, school users are encouraged to care for their school premises and to use resources efficiently. For example, monitors are being installed in social areas to give information such as the figures – in real time – for energy consumption, together with renewable energy production.

Overall, the school modernisation programme, which applies the recently revised HVAC[9] regulations, is regarded as a reference model and has also generated extensive empirical data to fuel study and analysis. In this context, PE has established several partnerships with universities and key entities; these bodies are participating in the evaluation of the new school designs and helping to rationalise its operation in relation to state-of-the-art energy efficiency. Through this collaboration, PE aims to generate and systematise further knowledge on school efficiency so it can be fed into broader regulations and practises.

CONTINUOUS CHALLENGES

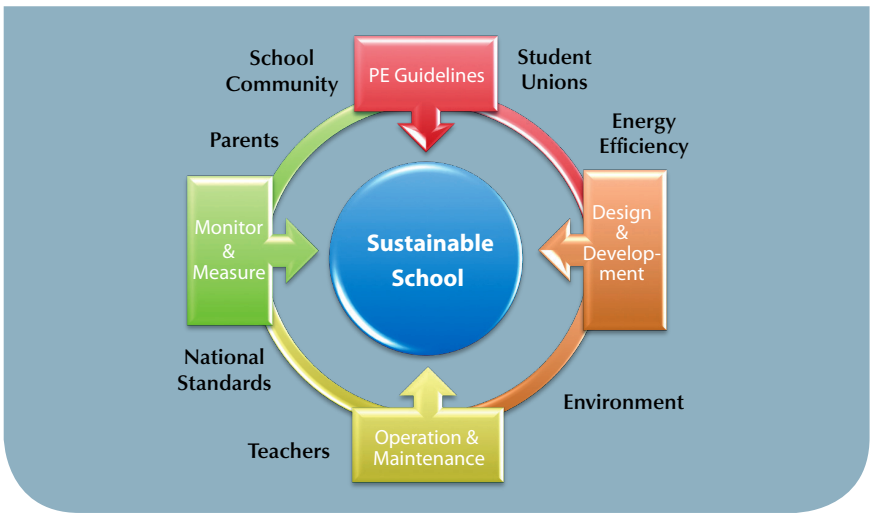
If all school facilities are to benefit from lessons learned during the development process of the early stages of the programme, a great deal of critical information needs to be recorded, studied and serve as input for the next stages. In order to cope with the fast-paced rhythm of the programme, PE has developed specific software applications which help track this information right from the design/tender stage through to the operational and maintenance stage.

These tools are designed to provide statistical data on the best solutions in terms of investment/life-cycle costs/quality, which allow PE design guidelines and projects to be continuously revised and improved. This process of on-going learning is essential for school sustainability. Its success is demonstrated by the fact that state-of-the-art practices have been extended to all PE school facilities.

8. CELE Exchange (2010), "OECD review of the secondary school modernisation programme in Portugal", OECD Publishing, *www.oecd.org/dataoecd/13/55/44708107.pdf*.

9. Heating, ventilation and air-conditioning systems.

The sustainable school: an evolutional matrix



Furthermore, the complexity of the new schools has called for a new management model. There is now a new focus on asset management, the responsibility of which has shifted from school board committees to PE. This allows schools to focus on their core function: education.

Alberto Sampaio Secondary School, Braga

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CONCLUSION

Parque Escolar is convinced that the management model described above can assure the long-term sustainability of its schools, as it stretches the concept of schooling beyond the realm of the building's life-cycle to encompass school activity itself. This global vision of the sustainable school leads to "sustainable schooling".

Given that there is close interaction during the design stage between schools and their stakeholders, customised solutions are proposed for each school building which is then tailored to the needs of its community. This collaboration impacts on the new dynamics of space usage and reinforces the sustainability of the project.

Educating school communities and raising their awareness begins with the example set by school facilities through high-level maintenance practices and asset management. These standards become references which can be extended to pedagogical activities in order to promote energy efficiency measures, as well as environmental and heritage awareness.

School facilities which implement best practises for energy efficiency and sustainability are actually setting the stage for what the government is seeking to bring about: a fully sustainable society.

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