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A Study of Energy Conservation Policies at (Primary) Eco-Schools in Istanbul

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Abstract

Approximately 50% of the energy produced on earth is used by buildings. As for all building types, ensuring the energy conservation in primary school buildings is important in many ways. In addition to environmental and economic benefits, the systematic application of sustainable energy consumption in primary school buildings also makes a positive contribution to the education of future generations. The “Eco-Schools International Programme” aims to introduce environmental management systems into primary schools within the scope of ISO 14001/EMAS.

This study examines primary schools in Istanbul that are part of the Eco-Schools International Programme. A questionnaire-based survey was administered on the theme of energy management within primary schools located in Istanbul city, and the findings of a field observation were examined. Questionnaire findings were categorized under three main themes: *energy usage and conservation policies at the eco-schools’ buildings’ envelope*, *energy usage and conservation policies in the indoor environments of eco-schools*; and *types of energy sources used at eco-schools*. According to the main results of the study; solar control elements on the facades, methods aimed at energy conservation from windows, energy-effective woodwork applications and independent control of energy systems (which are used in a small proportion of eco-schools) should be discussed and integrated in all eco-school buildings. It is seen that natural gas is used by 100% of survey respondents and that renewable energy resources are used only at low levels for testing purposes and/or to make small contributions to energy gain. In this context, expanded use of renewable energies at all the eco-schools should be considered.

Keywords: energy conservation, eco-schools programme, Istanbul eco-schools

1. Introduction

Rapidly increasing world population, technological developments and increase in standards of living have resulted in significant increases in demand for resources, particularly in energy consumption. The processes of energy generation and consumption are the most important factor in the depletion of global natural resources, the increase in CO_2 emissions to the atmosphere and, indirectly, global climate change. The necessity of energy for both natural and industrial systems is defined by Kibert, Sendzimir and Guy as follows: “Both natural and industrial systems require energy to reproduce and maintain their functions. Natural systems, for the most part, use solar flux or stored solar energy in the form of biomass for their functioning, whereas industrial systems use a wide variety of energy sources. In the present era, industrial systems operate largely by using stored solar energy in the form of fossil fuels, but these are being consumed at a pace of the order of 10,000 times their regeneration rate” (Kibert, Sendzimir, & Guy, 2002). Pitts makes the following explanation for the increased energy requirement and changes triggered by the industrialization process: “One of the most significant changes brought about by the industrialization process has been the almost complete reliance on non-renewable fossil-fuel based energy sources to provide the power, not just to drive the industrial processes but also to support the infrastructure, including construction, buildings and especially transport.” (Pitts, 2004).

The oil crises of 1973 and 1979 demonstrated to the industrialized countries their dependency on energy in order to sustain the living standards they had achieved. International Energy Agency (IEA) projections point out that, as long as the current energy policies and energy supply preferences continue to be pursued, global primary energy demand will increase by 40% in the period 2007-2030 (www.iea.org). While the world population has doubled since 1950, the energy demand has increased by 6 times. Global population is estimated to be 6.5 billion today and to increase to 7.2 billion in 2015 and 8.9 billion in 2050 (http://www.energy.itu.edu.tr/iTUOnerileri.pdf).

Building-related energy consumption represents a huge share of total energy consumption: "Buildings consume more than half the energy used worldwide (Gissen, 2002, p. 19). Due to their embodied and operational energy consumption, buildings have significant environmental effects. According to Graham, buildings affect the environment in the following ways (Graham, 2003):

- The physical disruption caused by mining energy resources,
- Pollution produced by energy conversion processes,
- Greenhouse gas emissions,
- Dealing with wastes.

Sassi suggests a three-step approach to minimize the environmental effects caused by the energy consumption of buildings: "First, building fabric design alternatives selected to provide the same performance with reduced energy requirements. Second, if a zero-energy design solution is not possible, active systems should be selected that use energy in an efficient way. Third, the resulting reduced energy requirements should be provided by alternative, low CO_2-emitting energy sources" (Sassi, 2006).

Energy conservation and management policies can be achieved by introducing the subject into laws and regulations, making comprehensive studies on this issue and raising public awareness. CHPS (Collaborative for High Performance Schools), one of the largest-scale studies on sustainable school buildings, emphasizes the environmental, economic and educational advantages of the subject as follows: "Energy-efficient schools cost less to operate, which means that more money can be used for books, computers, teacher salaries and other items essential to the educational goals of schools. According to the criteria specified under the "energy" title of CHPS, an additional 2-10 points can be awarded if the school building design contributes to reducing consumption by 10% or 15-35% of the National "Title 24-2001 California energy efficiency standards (CHPS, v. II.-III., 2009).

It is known that developed countries make various attempts to raise environmental awareness among primary education-aged children, who constitute the future of the society; School buildings serve as a useful tool in realizing such awareness-raising attempts. In this scope, many organizations have been established in order to minimize the negative environmental effects of school buildings; to take specific measures in various fields such as energy, water and waste; and to raise environmental awareness among children. The "Eco-Schools Programme", successfully implemented in different parts of the world, can be such an organization. Many Turkish schools are participants in the Eco-Schools Programme.

The present study assesses the energy usage and conservation methods at primary schools which are part of the Eco-Schools Programme and located in Istanbul. Istanbul is the largest city in Turkey with an area of around 5750 km^2 and a population of around 13.2 M (2012). The scope of the study includes detection and assessment of the following policies pursued by the eco-schools participating in the study:

- Energy usage and conservation policies at the eco-schools' buildings' envelope (building façade, windows and entrances of the school building),
- Energy usage and conservation policies in indoor environments (doors, lighting components, independent control of energy, motion/daylight sensors),
- Types of energy sources used at eco-schools.

Before discussing energy conservation in the eco-schools in Istanbul, the study briefly summarizes energy consumption in Turkey: During the period 1990-2008, the annual increase in primary energy demand was 4.3%, on average. During the last decade, Turkey had the most rapid increase in energy demand among OECD countries. Since 2000, Turkey has also seen the second-largest increase in demand for electricity and natural gas, after China. Projections of the Ministry of Energy and Natural Resources of the Republic of Turkey show that this tendency will continue in the mid-term (http://www.enerji.gov.tr/index.php?dil=tr&sf=webpages&b=enerji&bn=215&hn=12&nm=384&id=384).

When compared to global reserves, the primary energy resources in Turkey are low in terms of quantity and quality. The failure to meet the required quantity and quality and the high cost of energy generation from these resources, results in an energy deficit in Turkey. Turkey as an energy-importing country, smart transfer of energy technologies should be adopted to increase energy efficiency. In order to reduce and/or eliminate the energy deficit primarily appropriate energy-related policies should be determined and put into implementation (www.dtm.gov.tr/dtmadmin/upload/ead/tanitimkoordinasyondb/6sa7.doc).

2. Eco-Schools International Programme

Eco-Schools is a programme for environmental management and certification, designed to implement sustainable development education in schools by encouraging children and youths to take an active role in how their school can be run for the benefit of the environment (http://www.eco-schools.org). The Eco-Schools International Programme was developed as a response to some of the needs identified at the UN Conference on Environment and Development in 1992. The Programme started in 1994, with the support of the European Commission (DG XI and DG XXII), in 4 countries: Denmark, Germany, Greece and United Kingdom. In 1999, the organization received the "Worldaware Award for Global Education" from the North-South Centre of Council of Europe and NCDO. In 2003, Eco-Schools was identified by the United Nations Environment Programme (UNEP) as a model initiative for Education for Sustainable Development (http://www.eco-schools.org).

The Eco-Schools Programme employs an holistic, participatory approach, combining learning and action, thus providing an effective method for improving the environments of schools, raising awareness and producing behavioral change in young people, school staff, families, local authorities and others with a significant influence within local communities. Eco-Schools is one of the programmes of the FEE - Foundation for Environmental Education (www.fee-international.org) and, as such, it is implemented through FEE Member organizations (one per country). Currently, the Programme is being implemented in 47 countries around the world, involving 32,156 schools (9.898 of which have already been awarded with various Eco-Schools certificates), 9,125,460 students, 628,005 teachers and 5,013 local authorities. The Eco-Schools Programme is based on ISO14001:2004. The Eco-Schools methodology encompasses seven steps that any school can adopt (http://www.eco-schools.org).

In Step 2, work begins with a review or assessment of the environmental impact of the school. The results of the school's Environmental Review are essential to build the subsequent Action Plan, assisting the school to decide whether change is necessary, urgent or not required. The Review also helps schools to set realistic targets and measure their success. Schools may firstly quantify their impacts for the theme they are working on or cover all the areas in which the school may have environmental impacts, namely: waste management, waste minimization, school soils, biodiversity, energy, water, transport, health and well-being, and sustaining the world (http://www.eco-schools.org/page.php?id=53).

The action plan targeted creating in Step 3 is the core of the Eco-Schools work and is developed using the results of the environmental review (http://www.eco-schools.org/page.php?id=54).

Information and advice presented under the Eco-Schools theme of "energy" are included below:

The energy issues within the Eco-Schools programme suggest ways in which all members of the school can work together to increase awareness of energy matters and to improve energy efficiency within the school. Eco-Schools are required to carry out an energy audit as part of their Environmental Review and then set targets for reducing unnecessary energy use through their Action Plan. The "Environment and Innovation" project encourages Eco-Schools to come up with innovative and creative solutions to environmental problems. Winning entries receive a grant to help them put their ideas into action and to work with the local community to tackle issues.

The project's new, two-year cycle on "Climate Change: Let's Save Energy!" is active in six countries: Denmark, Finland, Italy, Norway, Turkey and Portugal (www.eco-schools.org/page.php?id=30).

From October 2008 as part of the European Energy Performance of Buildings Directive, all state schools with a floor area over 1000 m2 are required to display a certificate that rates their energy use on a scale of A-G. The new Display Energy Certificate (DEC) looks like the A-G rating you would expect to see when purchasing a new electrical appliance. It is part of the Green Flag criteria to include the school's DEC with the application to the Eco-Schools programme. This is so that the Eco-Schools project administrators can collect data to establish any trends (http://www.eco-schools.org.uk/nine-topics/energy.aspx).

3. Material and Method

The city selected for the present study, Istanbul, is the largest city by population and, economically, the most important city in Turkey. Istanbul has the 34th largest economy in the world and is the most crowded city in Europe (Wikipedia, 2010a). In this scope, data from the studies conducted in Istanbul will reflect the wider Turkish case at a significant level.

Directly proportional to economic development level and population, the number of educational institutions in Istanbul is higher than in other Turkish cities. Moreover, a great majority of the schools involved in Eco-Schools programs are in Istanbul. As of mid-2009, Istanbul had 55 schools participating in the Eco-Schools programme. Questionnaires were distributed to these 55 schools and 37 (67%) schools returned completed questionnaires. The distribution of participating schools located in the European and Asian sides of Istanbul is shown in Figure 1.

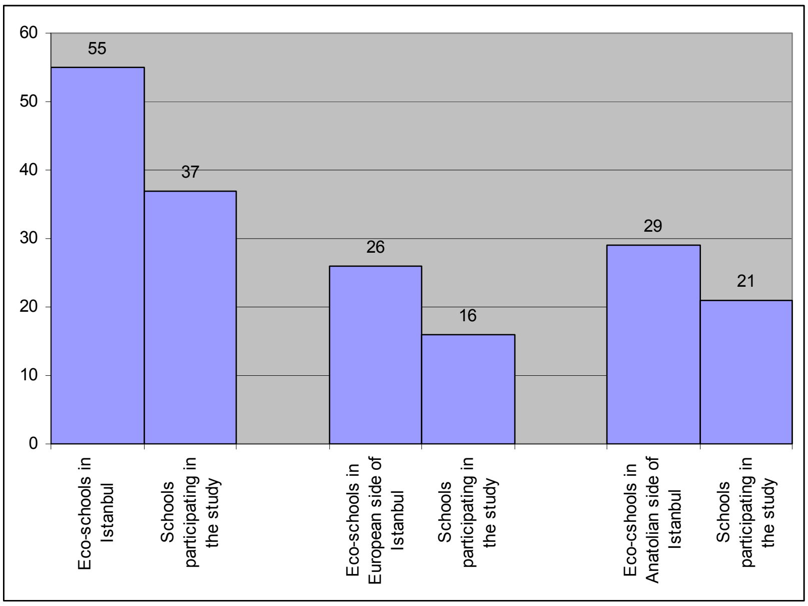

Figure 1. Distribution of Participating Eco-Schools in Istanbul

The present study used a structured review method. This is a quantitative research method that is used in survey studies. A previous study called *"Formal Environmental Review"* (Formal Environmental Review, 2010), produced by the Eco-Schools International Programme, was used as the basis when preparing the questionnaire. However, the questionnaire was revised according to the characteristics of the study site, in accordance with suggestions from the Eco-Schools Programme. The final questionnaire format consisted of 11 questions on the theme of energy conservation. The questionnaire generally consisted of closed questions, but an open-ended question was included to encourage additional comments from respondents. Questionnaire (Note 1) forms were emailed to Eco-Schools coordinators and administrators in private and state primary schools in Istanbul that participate in the Eco-Schools Programme. The contact details of coordinators and administrators was provided by the National Coordinator of Eco-Schools (Turkish Foundation for Environmental Education, 2009) of the Turkish Foundation for Environmental Education, which is the representative of the Eco-Schools International Programme in Turkey. The database used in the present study consisted of questionnaires completed and returned by 37 schools (see Figure 1). The frequency analysis functions within the SPSS statistical program were used to analyze questionnaire responses.

4. Case Study

Communication was established with Eco-Schools coordinators and administrators in these schools via e-mail, and they were sent the questionnaire. The main themes of the questionnaire study involve policies and interventions towards energy-efficiency related to the eco-schools' building facade, entrances and doors, selection of energy-efficient building equipment and components, energy sources and usage at eco-schools.

4.1 Energy Usage and Conservation Policies Related to the Building Envelope of Eco-Schools

According to Buchanan, in addition to efficient building insulation, it is of great importance to implement three basic strategies in ensuring energy conservation: "The whole form and organization of buildings should be shaped to be far less dependent on fossil-fuel energy; any mechanical plant (if indeed there is any) should be as efficient as possible, as should be the whole system of which it is part; and the building and its environmental systems should harvest and be fuelled by constantly replenished ambient energies (replenishable sources)" (Buchanan, 2005). In this scope, building form, the organization of the interior space, building orientation and building envelope play a significant role in ensuring energy conservation in buildings. In sustainable school design, these four design decisions should be tested separately in terms of energy conservation and energy saving (Tönük, 2001). However, the questionnaire administered to the eco-schools examined only the properties related to the building envelope.

Building envelope, in general terms, acts as a barrier between the indoor and outdoor environments. According to Tuluca, the basic function of the building envelope is as follows; "Increasingly, the building envelope is viewed not simply as protection from, but as connection to the environment. This connection is achieved by integration with the lighting, HVAC, and control systems. Envelope subsystems integrate several envelope functions (e.g. thermal protection, structural support, or water and weather protection) into a single, cost-effective component" (Tuluca, 1999).

4.1.1 Building Facades

Today, building facades are designed by taking into consideration factors such as reduction of energy consumption, prevention of environmental pollution and use of recyclable materials. Climatic facade designs are of great importance for the optimization of the energy loads caused by heating-cooling and ventilation systems of buildings. Such facades and the solar control elements used in facades aim to meet the comfort requirements of the building users by controlling external factors in order to ensure optimum energy consumption. Solar control elements can be placed either between the two layers of the double-skin building facades or on facade surfaces as an additional building element. According to Çetiner and Aygün, the energy cost of buildings with a double-skin facade is significantly lower than that of buildings with a single-skin facade (Çetiner & Aygün, 2005). Today, building facades may be equipped with overhangs; vertical fins; light shelves; low shading coefficient glass; interior space elements which prevent glare, such as venetian blinds; and adjustable louvers for solar control purposes.

Table 1. Energy efficiency methods used at building facades of eco-schools in Istanbul

Questions	Answers	Yes	No
Are there solar control elements on the school building's facades where required?	Frequency	3	34
	%	8.1	91.9
Does the school building have a double-skin facade?	Frequency	21	16
	%	56.8	43.2

Solar control elements in the building facades are used by only 8.1% of the eco-schools included in the present study (see Table 1), which emphasizes a deficiency in the "design with climate" approach adopted in the architectural designs of the study schools. In this scope, depending on the natural illumination conditions of the school building facades, it is suggested to equip facades with solar control elements. However, in order to prevent the retrofitting of solar control elements from damaging the structural system of the building, static calculations of the building and facades should be reviewed. It was found that 56.8% of the study schools use double-skin facade systems in the school building design.

4.1.2 Windows

The window design of primary education buildings is important in terms of both energy conservation and interior comfort. Window elements can significantly affect the heating and cooling requirements of a building. The study titled "The Efficient Windows Collaborative Tools for Schools" lists design and technical criteria related to the windows of the school buildings, as follows: "If the building location, window orientation, placement and size allow for sufficient daylighting, an integrated daylight control system should be considered early in the design process. Once orientation, daylighting, window area, and shading conditions are known, the window type must be chosen. When the window type is chosen, the effect of the window design on HVAC demand should be taken into account. Energy-efficient window design often allows for smaller and less costly HVAC systems, thus freeing funds that can be allocated to the efficient window technologies" (http://www.efficientwindows.org/ToolsForSchools.pdf).

Table 2. Energy efficiency methods used at the windows of eco-schools in Istanbul

Questions	Answers	Yes	No
Does your school building employ preventative methods to reduce heat losses from windows?	Frequency	17	20
	%	45.9	54.1
Are double-layer and energy-efficient window frame applications used?	Frequency	7	30
	%	18.9	81.1

Basic methods of reducing heat loss from windows:

- Draught excluding strips: Draughts are caused by cold air forcing its way through gaps around windows or doors. By blocking the gap, you will stop the draught, but it is very important not to block out the airflow designed to pass under the building via the air vents at ground level.
- Solar reflecting film: Such types of films attached to the window glass block solar UV radiation by 99.99% and reduce heat transfer by 60%.
- Responsive class window monitors: These elements, which are integrated particularly into classroom windows, adjust artificial illumination according to the natural illumination and turn on/off artificial illumination elements.

Table 3. Preventive method/methods towards reducing heat losses occurring from windows at eco-schools in Istanbul

State the preventive method/methods used at your school to reduce heat losses from windows			
Elementary Schools	Draught excluding strips	Solar reflecting film	Response. class window monitors
Irmak	√	-	-
Fenerbahçe	-	-	-
Kültür	-	-	-
Marmara	-	-	-
MEF	-	√	√
Önde	-	-	-
Sevgi Çiçeği Anafen	-	-	-
Sezin	-	-	-
Umutfono	-	-	-
Uğur	√	-	-
TED	√	√	-
Yenibosna Doğu S.	√	-	-
HEV Kemerköy	-	-	-
Anabilim	-	√	√
Altınyıldız	-	-	-
Eyüboğlu	√	-	-
İstek Acıbadem	-	-	-
İstek Acıbadem N.	√		√
Atanur Oğuz	√	-	-
İstek Belde	√	-	-
Mimar Sinan	√	-	-
ALEV	-	-	-
Atacan	-	√	-
Ataşehir Adıgüzel	-	√	-
Avrupa	-	-	-
Bahçeşehir Florya	-	-	√
Beykoz Doğa	√	-	√
Kartal Doğa	√	-	-
Üsküdar Doğa	√	-	-
Cent Nursery	√	-	-
Cihangir	√	√	-
Çamlıca Kalem	-	-	-
Kalemlik Nursery	-	-	-
Natuk Birkan	-	-	-
Derya Öncü	-	-	-
Elit Gençler	√	-	-
Enka	√	-	-
%	43.2	16.2	13.5

According to the results shown in Tables 2 and 3, 45.9% of schools used measures to reduce heat losses from windows, which suggests that this could be given greater emphasis in these schools. In this scope, it is suggested to implement easy-to-apply measures in order to decrease energy losses.

4.1.3 Building Entrances

Article 1.1.6. of Turkish Standard (TS) 9518 offers the following definition for the entrances and entrance gates of primary school buildings; "The main entrance and student entrance of the school building should be arranged separately; minimum width of the entrance gates should be 2.00 m and entrances should be equipped with a windbreak..." (TS 9518, 2000). In addition to the above-listed recommendations made in relation to school doors, a "self-closing mechanism" applied on gates can be used as another measure to prevent energy loss. The eco-schools questionnaire study also includes a question on this mechanism.

Table 4. Preventive method/methods towards reducing heat losses occurring from building entrances of eco-schools in Istanbul

Questions	Answers	Yes	No
Is there a self-closing mechanism on your school building's entrance gates?	Frequency	6	31
	%	16.2	83.8

4.2 Energy Usage and Conservation Policies for Indoor Environments of the Eco-Schools

There are various "sustainable school buildings guidelines" developed to direct sustainable energy usage and energy conservation policies to be adopted by schools. Most of these design handbooks include information and suggestions related to implementing energy management in the building design, maintenance and operation processes. The energy title of the BREEAM Education Guideline, published in England, emphasizes the reduction of CO_2 emissions as a top priority; "To recognise and encourage buildings that are designed to minimise the CO2 emissions associated with their operational energy consumption" (BREEAM Education, 2008). LEED for Schools, implemented in the USA, explains the target under the title of "optimize energy performance" as follows: "To achieve increasing levels of energy performance beyond the prerequisite standard, to reduce environmental and economic impacts associated with excessive energy use" (LEED for Schools, 2009). The Massachusetts High Performance Green Schools Guidelines state: "Model the school using LEED energy savings calculations protocol (version 2.1 of LEED) to show that it will achieve 20% less energy cost than a Massachusetts energy code minimum building (780 CMR Chapter 13), regulated loads only" (http://www.chps.net/content/034/MA-CHPS_2006.pdf). CHPS, which issues various guidelines on sustainable school buildings, promotes 16-46% reductions in the energy consumption of school buildings (http://www.chps.net/content/032/CA_CHPS_Criteria_2009.pdf).

Findings related to indoor energy usage in eco-schools are listed below. The questionnaire is intended for interior doors, energy and illumination equipment and components.

4.2.1 Interior Doors

According to Article 1.2.12.2 of TS 12014, "Classroom doors should be placed on the wall between the front desk and the board and they should open outward. Classroom doors opening to the same corridor should not oppose each other, to ensure easy evacuation in case of panic." (TS 12014, 1996).

As with the building entrance gates, a self-closing mechanism -to be placed on the interior doors- retains indoor heat and ensures energy conservation. As stated by Stitt, "Doors represent a compromise between conflicting needs: it will not be possible to move from room to room, to foster or prevent air exchange, and to interpose a temporary wall across an opening, for privacy" (Stitt, 1999).

Table 5. Preventive method/methods towards reducing heat losses occurring from interior doors of eco-schools in Istanbul

Questions	Answers	Yes	No
Is there a self-closing mechanism on your school's interior doors?	Frequency	29	8
	%	78.4	21.6

According to the findings, presented in Tables 4 and 5, while a self-closing mechanism is applied on the exterior doors of the school buildings at a low rate of 16.2%, it is applied on interior doors at a high rate of 78.4%. It is suggested that this system should also be applied on the exterior doors of school buildings in order to ensure energy conservation.

4.2.2 Energy and Lighting Equipments and Components

The energy consumed for artificial illumination represents an important proportion of the total energy consumed by buildings. According to Bougdah, "Globally, electric lighting consumes approximately 20 percent of the world's generated electricity. In buildings, electric lighting typically accounts for around 50 percent of total electricity use in offices, 25 percent in hospitals and 15 percent in schools and homes. Energy efficiency in electric lighting involves the correct choice of lamp, luminaire and control strategy (so lighting is supplied only when it is needed) (Bougdah, 2010). Determining appropriate illumination systems for school buildings is an important step towards energy saving; however, the most important saving in this scope is natural illumination of the school building. According to the information included in High Performance School Buildings, "Daylighting can also save school money. Properly designed systems can substantially reduce the need for electric lighting, which can account for 35% to 50% of a school's electrical energy consumption. As an added benefit, waste heat from the lighting system is reduced, lowering demands on the school's cooling equipment" (Illinois Resource Guide for Healthy, High Performing School Buildings, 2006). Moreover, natural illumination has been proven by many studies to have positive effects on the sustainability of student performance as well as on energy saving (Heschong, 2009; Kuller & Lindsten, 1992).

Classrooms that face different frontages are affected differentially by climatic conditions and, in turn, have different energy needs. In this context, energy systems need to be managed independently for each classroom, which will bring important advantages in terms of energy saving.

Table 6. Usage of energy efficient building equipment and components at the eco-schools in Istanbul

Questions	Answers	Yes	No
Are low-energy consumption bulbs or fluorescent lights used at your school?	Frequency	14	23
	%	37.8	62.2
Is there independent control of energy systems in your school's classrooms?	Frequency	5	32
	%	13.5	86.5

The Massachusetts High Performance Green Schools Guidelines provides for a maximum of 1.0 Watts/ft^2 as the average illumination equipment energy density for the whole school. In addition, it recommends that technologies such as "occupancy sensors, timed lighting schedules, and/or timed switches, which shut interior lights off when spaces are unoccupied for 15 minutes or more" should be used in school buildings. Light switches shall be installed such that more than one level of artificial illumination is possible. Each regularly occupied perimeter and non-perimeter space enclosed by ceiling-height partitions shall have a manual control to allow the occupant to uniformly reduce the connected lighting load by at least 50% (MA-CHPS_2006).

Table 7. Usage of motion/daylight sensors at the eco-schools in İstanbul

Question	Answers	Yes	No	Sometimes
Are lights and other electrical components at your school fitted with motion/daylight sensors?	Frequency	7	15	15
	%	18.9	40.5	40.5

The limited use, in 13.5% of schools, of energy control systems that can be managed independently for each classroom; and sunlight-sensitive sensor systems (which lead artificial illumination elements) in 18.9% of schools suggests that the study eco-schools do not attach due importance to these issues. It is suggested that schools ensure the installation of such systems in the school buildings, both to reduce costs and to increase awareness of electricity use in their schools.

4.3 Types of Energy Sources and Usage at Eco-Schools

The Organization of Eco-Schools summarizes the energy-related steps to be taken by a candidate eco-school as follows: "School energy conservation efforts usually begin with a comprehensive energy audit, frequently conducted by the students (of any age), to determine where the school is wasting the most energy--and money. Many schools have saved energy and money by following the students' recommendations and changing these simple practices. Some schools also seek to conserve energy through the use of strategically planted shade trees that cool air-conditioning units (in warm climates) and reduce the amount of heat absorbed by surrounding asphalt. Other schools have gone to the next step and decided to generate energy on-site. Solar panels and wind turbines are the most common choices at schools, and can be installed in a variety of sizes and combinations. Small systems can do things such as power a pump for a schoolyard pond or provide the energy for night lighting in a schoolyard. Larger systems can be connected to the school's main power supply, or the neighbourhood power grid, and offset-or entirely replace-the school's energy needs. A few schools have tried other renewable energy systems that require further modifications of their buildings' structures or other specialized equipment. Some have installed geothermal energy systems that circulate incoming air through underground ducts to pre-heat or pre-cool it before it enters the rest of the ventilation system. Other schools use passive solar energy systems that rely on the interaction between the climate and the building's design for much its heating, cooling, and lighting (http://www.ecoschools.com/Energy/Energy_wSidebar.html).

CHPS California Guidelines also provide for the use of on-site renewable energy resources to meet a part of the energy consumption of the school building and specifies this rate to be 1%-90%. (CHPS, 2009). Similarly, the LEED for Schools Guidelines emphasize the use of on-site renewable energy self-supply rather than fossile fuels (LEED for Schools, 2009). "To encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis. Engage in at least a 2-year renewable energy contract to provide at least 35% of the building's electricity from renewable sources, as defined by the Centre for Resource Solutions' Green Energy product certification requirements" (LEED for Schools, 2009).

Aware and economic use of energy, as well as utilization of clean energy resources and energy generation from natural resources, constitutes an important part of the themes of "sustainable energy management" and "sustainable energy policies". The Energy Guidelines (2009) state: "Energy sources must be monitored for verification of actual energy usage for operation of the facility. Electrical energy, natural gas or propane systems should be monitored 24-hours a day, 365-days a year. The building automation system should be used to constantly monitor, archive data and totalize the electrical energy usage" (Energy Guidelines, 2009).

Table 8. Distribution of the energy sources used at eco-schools in Istanbul

Which of the following energy sources are used at your school?							
Elementary Schools	Wind generator	Solar water PV heating panels	Petroleum-based energies	Ground source heat pump	Coal	Natural gas	Other
Irmak						√	
Fenerbahçe						√	
Kültür						√	
Marmara						√	
MEF						√	
Önde						√	√
Sevgi Çiçeği Anafen						√	
Sezin						√	
Umutfono						√	
Uğur						√	
TED						√	
Yenibosna Doğu S.						√	

Which of the following energy sources are used at your school?							
Elementary Schools	Wind generator	Solar water PV heating panels	Petroleum-based energies	Ground source heat pump	Coal	Natural gas	Other
HEV Kemerköy						√	
Anabilim			√			√	
Altınyıldız						√	√
Eyüboğlu						√	
İstek Acıbadem						√	
İstek Acıbadem N.						√	
Atanur Oğuz						√	
İstek Belde						√	
Mimar Sinan						√	
ALEV						√	
Atacan		√					
Ataşehir Adıgüzel						√	
Avrupa							
Bahçeşehir Florya						√	
Beykoz Doğa						√	√
Kartal Doğa						√	
Üsküdar Doğa						√	
Cent Nursery						√	
Cihangir			√			√	
Çamlıca Kalem						√	
Kalemlik Nurs.						√	
Natuk Birkan		√		√		√	
Derya Öncü						√	
Elit Gençler						√	
Enka						√	
%	0	5.4	5.4	2.7	0	100	8.1

According to the findings listed in Table 8, all schools use natural gas as the main energy source for heating. Other renewable energy resources are used at very low levels, to support natural gas systems. This situation results from extensive use of natural gas in Istanbul. Active use of renewable energy systems such as ground source heat pump, wind and solar energies remains at significantly low rates both within Istanbul and across Turkey. However, solar and wind technologies are widely and actively used on the Aegean and Mediterranean coasts, particularly within tourist facilities. The development of a renewable energy resources industry in Turkey and public tendency to use such resources will be decisive in the adoption of such systems in Turkey.

In addition to the energy conservation strategies listed in the tables above, the additional information given under the title of "other" (Note 2) shows that several of the study eco-schools have adopted a range of additional energy-conservation technologies, as follows:

In the indoor environments of Beykoz Doğa College, transformers are used to reduce 220 volt to 12 volt to use 4×18 energy saving fluorescence lights in interior illumination and time-adjusted illumination elements for outdoor illumination. Photoelectric bulbs are preferred in barns, animal shelters and similar outdoor spaces. In Hisar Education Foundation, only the electrical equipment in the toilets is reported to be of sensor type. In Atanur Oğuz Primary School, time-adjusted solar sensors are used to ensure energy control in the classrooms. In Hisar Educational Foundation Kemerköy Schools, special attention is paid to the use of low-consumption ampoules. A Saving Committee -established by the school organization- record all the consumptions such as energy, water, paper, paper cups, natural gas, etc., in order to find consumption solutions. In Umutfono Primary School, an "eco-team" composed of students and personnel raise awareness among other students about the conscious use of energy resources. In Önde College, waste hot water obtained from the thermal plant is used for heating and natural gas is used only in the cafeteria. In Natuk Birkan Primary School, solar energy is used in the sports tents, geothermal energy in the lobby and swimming pool and natural gas in the other places.

5. Results and Discussion

Schools in countries with different development levels can participate in the Eco-Schools Programme. It is therefore impossible to achieve an equivalent level of success in terms of energy conservation in all Eco-Schools. However, the documentation of the activities carried out by the member schools as part of the program will enable local and global comparisons of these schools. Such data will reveal the strengths and weaknesses of these schools and will enable project administrators to make future projections on these issues.

The questionnaire investigated the strengths and weaknesses of the energy conservation policies adopted by Eco-Schools in Istanbul (55 total, 37 survey respondents).

The study findings show that there are some deficiencies in the awareness and economic use of energy in the indoor and outdoor environments of the eco-schools located in Istanbul that participated in the study. Based on the findings of the present study, the following recommendations can be made for the progression of eco-schools in Istanbul:

- Taking into consideration the findings listed in Table 1:
  - Solar control elements should be applied on the facades, according to how much sunlight they receive,
  - The use of double-skin facades should be discussed when constructing new buildings and in comprehensive building renovations,
- Taking into consideration the findings listed in Table 2:
  - Preventive measures should be considered in all eco-schools to reduce heat loss from windows and double-skin and energy-effective woodwork applications (which are in limited use in the eco-schools) should be generalized to all eco-schools,
- Taking into consideration the findings listed in Table 3:
  - Methods aimed at energy conservation from windows (which are used in a small proportion of eco-schools) should be discussed and should be integrated in all eco-school buildings,
- Taking into consideration the findings listed in Table 4:
  - Self-closing mechanisms (which are in limited use on the entrance gates of some eco-schools) should be integrated to the entrance gates of all eco-schools,
- Taking into consideration the findings listed in Table 6:
  - Low-energy consumption bulbs and fluorescence lights, which are used widely in the indoor environments of the eco-schools, should be generalized to the indoor environments of all eco-schools,
  - Independent control of energy systems, installed in a small proportion of the eco-schools- should be integrated to all eco-school environments,
- Taking into consideration the findings listed in Table 7:
  - The use of sensors mounted on illumination elements and other electrical elements should be generalized in the eco-schools,
- Taking into consideration the findings listed in Table 8:
  - It is seen that natural gas is used by 100% of survey respondents and that renewable energy resources are used only at low levels for testing purposes and/or to make small contributions to energy gain.

The initial investment costs of advanced technologies -used for renewable energy gain purpose- remain at significantly high levels. Although this presents less of a problem for developed countries, these high costs are a real problem for developing countries. However, it is concluded that the study schools, which are labeled as "eco-schools", should pioneer the use of such technologies and should create special budgets for the adoption of renewable energy resources.

Considering the general results, it is recommended:

- To gradually apply the same or similar applications in all primary schools in Istanbul and Turkey.
- To add educative seminaries and/or compulsory lessons on the topics of "environment", "environmental awareness", "energy conservation and management" to the curriculum in addition to basic education subjects.
- To seek active support from professionals in the fields of "education" and "environment and renewable energy systems" (universities, those working in applied fields, non-governmental organizations, provincial governments etc.).

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Notes

Note 1. The results of the questionnaire study, which is conducted under the approval and permission of Istanbul Provincial Directorate for National Education (İİMEM), have to be published and these publications must also be delivered to İİMEM.

Note 2. The necessary permission to publish school names in academic studies and publications conducted and to be conducted on eco-schools in Istanbul was received from the National Coordinator of the Turkish Foundation for Environmental Education (TURÇEV) Eco-Schools Program via e-mail in April, 2012.