ENVIRONMENTAL PROTECTION – CASE STUDY OF THE SCHOOL UNITS OF PIKERMI IN GREECE

Agisilaos Economou
National Technical University of Athens, Nikaias 18,17122, Athens,Greece, e-mail: aghs@mail.ntua.gr

Summary

Nowadays, since environmental problems have become acute, the sustainability of buildings is becoming more important. In addition, new buildings should be adapted to the requirements of the time for use of green energy, reduction of energy consumption, while providing a healthy and comfortable environment.

This research examines the contribution of schools in the development and protection of the environment. Specifically, the research focuses on school units in Pikermi and particularly on the construction of a pre-school, and primary and secondary schools.

The research, taking into account the policies and legislation at a national and European level as well as the design studies and construction of schools, assesses the protective measures that have been taken in order to reduce pollution to natural resources and to preserve those resources.

The results showed that today important efforts to apply new methods in order to reduce not only energy requirements but also to reduce the pollution in areas surrounding schools are taking place. According to the research, these measures contribute to the sustainability of schools as well as the preservation of natural resources. Furthermore, the new design of schools combined with environmental education can play an even more substantial role.

Keywords: Save energy in school units, Environment protection in school units, school units of Pikermi

1 Introduction

Nowadays, ways are sought to ensure to users of buildings better environmental conditions (thermal comfort, lighting and indoor air quality) with minimal energy consumption and smaller environmental impact on the natural resources in the area.

Thus, the schools units should adapt to new requirements for a healthy and comfortable environment of learning. Recently in Greece, many efforts are made to build new schools, according to new environmental standards. The efforts refer to construction as well as to measures which have been taken to reduce environmental repercussions.

The whole action, refers to using both climatic conditions and technology. Thus, bioclimatic design, automated systems for electrical equipment (smart buildings) and adjustable time water flow valves have been introduced in the construction of schools units.

In school buildings, 70% of the energy consumed for heating and 30% for lighting. The aim is to implement an appropriate design, depending on the particularities of each area in order to reduce energy consumption both during the winter for heating, and during

the summer for cooling and ventilation [1]. Also, the using of materials that are environment friendly as well as the various forms of energy used in schools, such as oil, gas, geothermal energy, solar energy, electricity and others play an important role in protecting the environment.

To ensure a better environment, ventilation systems with CO_2 sensors, hybrid systems such as solar chimneys with or without ventilator and others are used.

In Greece, the principle of a school unit placement on the land is the optimal use of solar radiation. Thus, the placement of the school unit should ensure a high level of lighting during the year as well as a maximum solar gain during winter and shading during the summer months. At the same time, it must also ensure the ventilation of the premises, bright light in each area as well as two-way through and through lighting, so that rooms are adequately illuminated. Usually, the orientation of schools units is on the north-south axis, because southern orientation offers the maximum solar radiation inside buildings during winter and the northern orientation provides indirect diffuse light throughout the day [1].

2 Case study (Schools units of Pikermi)

2.1 Research area

The area of Pikermi geographically located in eastern Attica (fig. 1). With regard to the microclimate, the area belongs to the B climate zone [1], according to the rules of insulation, so it has the same needs for cooling and heating.

Fig. 1 Research area

In this area, in a plot area of 9357.6 square meters, studies on the construction of three schools for the purposes of education took place (fig.2). Specifically:

Fig. 2 School area of Pikermi [11]

Tab. 1 School Units of Pikermi [2]

School Units	**Floors**	**Area of building** (m^2)	**High of building** (m)	**Population** (person)
Nursery school	1	451.15	3.60	97
Elementary school	2 and basement	3314.14	7.60	664
High school	2 and basement	3314.14	7.60	674
Total		7079.42		

2.2 School units placing

Firstly, for the construction of schools units the local street plan was approved in the out planning area and in limits of the General Building Planning of Pikermi' community (Prefecture of Attica) [3]. After, the provisions of General Construction Regulations (GCR) of 1985 & 2000, the existing building conditions in the area, the allowable coverage 40%, the building factor of 0.60, the maximum height of 8 meters and 1.50 meters roof (optional) were taken into account.

Generally, the placement of schools units in the plot obtained after taking into account a number of parameters such as the orientation of buildings, the basic shape of the building, construction materials which will be used, the arrangement of the types of construction sites as well as the desired indoor and outdoor environmental quality of the building.

For the orientation of schools units and understanding of the characteristics of the land, the solar orbit in the area, local vegetation, topography of land and microclimate of the area are taken into account.

2.3 Measures and actions to protect the environment

During the construction of schools units several measures to protect the environment have been taken such as:

- Infrastructure network

In all schools units water-network, drainage system and rainwater collections systems are built in accordance with Greek regulations.

During the construction of water supply and drainage system measures for the protection of the network from any reversal of water from hydraulic shocks in order to avoid mix between fresh water and sewages. Also, the legal provisions for waste disposal and environmental protection are taken into account. Additionally, in all water network systems water filters will be installed in water supply mains of buildings (before the collector) [4] and regulated flow time valves for water saving.

- Parking

In the basement of the elementary unit committed parking for 12 cars.

- Waste management

Regarding the sewage management a unit of biological treatment and a watering system, one for each school unit will be constructed. Specifically:

A compact sewage treatment system is used (second level of biological treatment, with prolonged ventilation). The requirement of sewage treatment in the area and its capacity depends on the number of students and water consumption. For example, the biological treatment of a nursery unit is built for maximum concentration of 300 mg / lit (ppm), (Organ load of BOD_5 per person 60 gr, water consumption / person / day = 200 lit). The space required for this biological unit are: 1.75 height and 1.65 in diameter [4].

- Management system of treated water

Waste water from laboratories sinks, before reaching the main drainage network, are concentrated in a neutralization tank via a network. The treated water through the sewage treatment after decontamination is stored in a collection tank. After it will be used for irrigation of green area (subsoiling irrigation). The boiler water is used for the irrigation of turf (lawn areas - clover) (overhead irrigation). The chlorination of water will take place every year [7].

The biological sludge which is produced from sewage treatment, is transported to the biological treatment unit of Psittalia (third level) for further processing and disposal.

- Gas installation in school unit

According to the decision to replace oil burners with gas burners at schools units in Attica, the installation of internal gas installations in schools units, is now necessary.

The installation of networks takes place in accordance with the internal regulation of natural gas facilities with operating pressure up to 1 bar [5]. The gas system is placed at least 5cm from the water network and 10cm from the electric network [8].

The gas installations are (pipes, equipment, appliances, flues, chimneys), are inspected and maintained by a qualified person at least once a year.

- Photovoltaics

To cover the needs for energy, a study for the installation of photovoltaics on the roofs of buildings of elementary and secondary schools was undertaken. The photovoltaic system consists of 60 panels, with a total power 13.80 kWp each [6]. The installation of photovoltaic systems will be interconnected with the electrical current network of Public Power Corporation (PPC).

- Other protective measures

For all schools, nursery, elementary and high schools, there have been studies for active fire and lightning protection [4].

The sound protection of schools is achieved through the correct orientation of the building and spaces in it as well as by appropriate landscaping, including planting trees, shrubs, solid walls, terraces, and others.

The plants should be sited as to ensure maximum use of solar radiation. While the building openings such as windows and skylights the physical design of the building is achieved, allowing natural light into the interior of schools. Also, studies on insulating walls and roof of schools units have taken place. Thus, a direct insulation shell can be achieved using the principle of heat insulating material such as mineral wool and polyester, special thermal insulating bricks etc [1].

Furthermore, the use of ventilation with CO_2 sensors will contribute more to improve the environmental quality in school buildings.

In addition, new programs and activities such as recycling will contribute more to environmental protection as well if combined with environmental education.

2.4 Saving and reducing environmental repercussions

The design of the building for natural light and ventilation saves electricity which would be required to illuminate the building and the air conditioning, heating or cooling, after the above measures reduced internal heat loads.

Also, energy saving is achieved by insulations measures. Due to the fact that the area belongs to the second climate zone, the thermal insulation of exterior walls make a saving of 24%, while the internal walls also contribute to energy saving by 38% annually. In addition to this, a roof insulation saves 7% in energy.

In addition, the use of photovoltaic systems saves energy. According to the studies of PV, the total capacity that will be installed in elementary and high Schools is ($13.8 \cdot 2 =$ $= 27.6$ kWp).

Taking into account that 1 kWp (crystalline silicon) for the Pikermi area produces 2270 kWh/year/m^2 or 2340 KWh/year/m^2, in the case of using 2-axis tracking systems for scope 25% (fig. 3) (estimated losses 14.0%). Thus, during one year, photovoltaic systems (27.6 kWp) produce a total of 62652 kWh or 64584 kWh for 2-axis tracking systems [9]. The 62652 kWh corresponding respectively to 47 tones of CO_2 for which 141 trees would be required for its absorption. While the 64584 kWh equivalent to 48.4 tones of CO_2 which would require 145.3 trees [10].

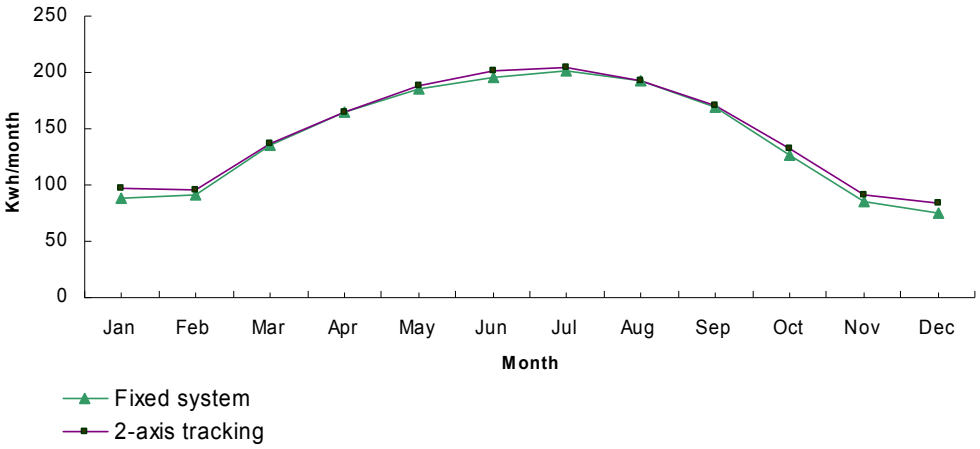

Fig. 3 Average monthly electricity production from the given system (kWh) [9]

Thus, the use of photovoltaic systems has also been saving energy and protecting the environment by reducing emissions of greenhouse gases. Furthermore, the use of gas instead of oil, will have as a result the avoiding of pollutants emitted into the atmosphere.

With regard to measures for the treatment of wastewater and reuse of waste as well as the installation of time regulated water flow valve will contribute in saving and conserving the area's water resources.

3 Conclusions

Current research shows that schools can contribute to facing the climate change by using renewable energy such as solar energy. At the same time, the development of biological treatment in schools that are not connected to the main drainage systems of the town, reduces the water pollution, while the reuse of wastewater for irrigation of green spaces, saves water resources.

In addition it is found that the above measures to protect the environment should be revised in accordance with changes in bioclimatic design technology.

Technologies for saving energy by reducing consumption as well as the bioclimatic design are two important tools which already begun to play a key role in the design and construction of new school units. Thus, new school units, designed to protect the environment combined with environmental education and recycling may provide more into the sustainable development of the community.

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