MOVING TOWARDS ENERGY EFFICIENT BUILDINGS IN CYPRUS

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Provincia di Savona

Sustainable Construction in Rural and Fragile Areas for Energy efficiency

Contents

1. Introduction

Buildings consume about 40% of the total energy used in the EU and this consumption is responsible for 30% of carbon dioxide emissions[1]. Specialized studies showed that there is a large potential for energy savings in this sector[2]. Particularly for Cyprus, the building sector consumes 37% of Cyprus's total energy needs and the fact that until recently there was no legislative regulation concerning the insulation of buildings, the potential of savings is even larger[3].

Buildings consume energy in two main ways. The energy consumption is

1. for space heating in winter, in the form of oil-burning in the boiler, or in the form of electricity for cooling or heating the building with air conditioning, lighting which is the 80% of the total building's consumption, and
2. for the operation of electrical appliances (TV, washing machine, water heater, etc) which is the 20% of the total building's consumption. This electricity uses mainly heavy fuel oil to be produced.

There is a third way that energy is incorporated into a building .The choice of materials that are used to construct a building has an inherent energy content. Any material to be produced, consumed energy in its manufacture. This action is called embedded or embodied energy. [4] This can be viewed as analogous to capital cost (capital energy) and operating costs (operation energy).

The phase of building planning is critical because it determines its energy behaviour. Energy planning should contribute to the avoidance of unnecessary energy use and to safeguard comfortable indoor climatic conditions (thermal comfort) in relation to the outside temperature.

The energy plan is based on four principles:

1. Bioclimatic design of buildings and surroundings.

2. Use of appropriate systems of low energy consumption

3. Energy management with suitable systems, which ensure the permanent monitoring and the control of energy use systems of a building. This system, known as BEMS (Building Energy Management System), constitutes the unique solution for the coordinated and rational operation of modern installations in medium and big building groups but can also be applied to single dwellings.

4. Exploitation of available renewable energy sources (RES) for the partial or total energy needs of the building.[5]

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[1] European Commission, *Doing more with less*, Green Paper on energy efficiency 22.06.2005 COM (2005), 2005.
[2] European Commission, *Action Plan for Energy Efficiency: Realising the Potential*, Brussels, 19.10.2006 COM (2006)545, 2006
[3] Florides, G., Kalogirou, S., Tassou, S., Wrobel, L., Modelling of the modern houses of Cyprus and energy consumption analysis, *Energy - The International Journal*, 25(10), pp. 915 - 937, 2000.
[4] http://www.solon.org.gr 10-02-2012
[5] S. Perdios presentation energy report in Athens 25-11-2006

2. European law

The Directive on Energy Performance of Buildings (2002/91/EC) is the main legislative instrument at EU level to achieve energy performance in buildings. Under this Directive, the Member States must apply minimum requirements as regards the energy performance of new and existing buildings, ensure the certification of their energy performance and require the regular inspection of boilers and air conditioning systems in buildings.

In 2008 the Commission presented a proposal of recast Directive in order to strengthen the energy performance requirements and to clarify and streamline some of its provisions. A political agreement on the substance of the recast Directive was reached on 17 November 2009.

The four key points of the Directive are:

- a common methodology for calculating the integrated energy performance of a building's minimum standards on the energy performance of new buildings and of existing buildings that are subject to major renovation
- Systems for the energy certification of new and existing buildings and, for public buildings, prominent display of this certification and other relevant information. Certificates must be less than five years old
- regular inspection of boilers and central air-conditioning systems in buildings and in addition an assessment of heating installations in which the boilers are more than 15 years old.
- The common calculation methodology should include all the aspects which determine energy efficiency and not just the quality of the building's insulation. This integrated approach should take account of aspects such as heating and cooling installations, lighting installations, the position and orientation of the building, heat recovery, etc.

The minimum standards for buildings are calculated on the basis of the above methodology. The Member States are responsible for setting the minimum standards.[6]

[6] http://europa.eu/legislation_summaries/other/l27042_en.htm 08-02-2012

3. Cyprus law

For the purposes of compliance with the European Community Directive 2002/91/EC Cyprus issued the "energy efficiency of buildings" laws of 2006 and 2009 (N142(I) 2006 and N30(I) 2009)

Law N142(I)2006 sets the minimum energy efficiency, energy performance calculations and energy performance certificate of buildings and apartments. At the same time imposes the display of an installation's certificate in a place conspicuous, for the public (e.g. websites, libraries). Finally it defines and enforces the proper maintenance of heating systems, cooling systems and boilers.

This legislation recommended the structure of advisory services while it provides the definition of the framework of the inspector's body's powers, procedures and inspection.

This legislation came partly into force on December 21, 2007. On the same day were also in force "The Streets and Buildings (Energy Performance of Buildings) Regulations 2006" ΚΔΠ 429/2006. With the entry into force of the Law and the Regulations, all new buildings and those with a total useful floor area over one thousand square meters (1000 m^2) which undergo major renovation should fulfill the requirements for thermal insulation of the building shell, satisfying the maximum allowable U[7] specified by Ministerial Order ΚΔΠ 446/2009. For the purposes of the legislation the designer of the project should, at the stage of filing the application for a building permit, submit to the competent authority the following additional information:

1. A solemn declaration that the building fulfills the requirements of thermal insulation for the shell.
2. Calculations' confirmation that the U of the various structural components of the building does not exceed the maximum allowable, as set out in the Order ΚΔΠ 446/2009. New buildings with a total useful floor area over one thousand square meters (1000m^2) should, at the design stage, investigate the technical, environmental and economic feasibility of alternative energy systems such as:
    - Decentralized energy supply systems based on renewable energy
    - Cogeneration systems of electricity and heat
    - Heat pump systems, if there are suitable conditions.

The results of the investigation should be reported in a solemn declaration. The implementation of legislation excluding buildings for which an application for a building permits or planning permission has been submitted to the competent authority before December 21st 2007.

To inform the public and those who are involved with engineering issues and design, the Energy Agency of the Ministry of Commerce, Industry and Tourism has prepared the relevant "Building Insulation Guide" which defines the method of calculating the energy efficiency of buildings. As part of this legislation in force are also the "Calculation Methodology for Energy Efficiency in Buildings Ordinance of 2007" and the "Minimum Requirements for Energy Efficiency: Building Ordinance 2007". Finally,

[7] thermal transmittance

recently came into effect the Regulations for "The Control of the Energy Performance of Buildings (Inspection of air conditioners) Regulations of 2009.

3.1 Regulation 429/2006 on Roads and Buildings (Energy Performance of Buildings) ΚΔΠ 429/2006)

This regulation applies to all cases of new buildings and in the case of buildings with total useful floor area over one thousand square meters (1000m^2) which undergo major renovation. Under this regulation the following documents and calculations which are defined in the "Energy Efficiency of Buildings Law" should be submitted to the Competent Authority (Municipalities or District Administration) as appropriate:

- An affidavit that the building fulfills the minimum energy efficiency requirements
- Calculations of the building's energy efficiency
- If a building's total useful floor area is over one thousand square meters (1000m^2) and undergoes major renovation and the upgrading of the energy efficiency is not feasible, a techno-economic analysis should substantiate this fact,
- The building's energy performance certificate

The energy performance certificate (EPC) is being prepared and published by qualified experts as it is defined in the "Regulation of the Energy Performance of Buildings Act" and notified to the Energy Agency.

The EPC and recommendations' report can only be issued by a Qualified Expert. The QEs[8] are separated into two categories: a) QEs for residential buildings and b) QEs for non residential buildings. All QEs must have a degree in architecture, or electrical engineering, or mechanical engineering, or civil engineering and be members of ETEK (Cyprus Technical and Scientific Chamber).

- For residential buildings, they have to have three (3) years of experience in their field and have passed a national examination
- For non-residential buildings, they have to have six (6) years of experience and have passed an examination, and it is a prerequisite that they have already passed the examination for residential buildings.

3.2 Calculation methodology on energy efficiency building ordinance of 2007 (ΚΔΠ 414/2009)

This ordinance is adopted pursuant to Article 14 of Law 142 (I) of 2006 and refers to the calculation methodology of energy efficient of building. This Ordinal sets a methodology for calculating the integrated energy performance of buildings and building units and has effect from the legislation date. Under this ordinance, the building energy performance calculations and U shell's coefficients calculations

[8] Qualified Expert

are prepared as described in Chapter 6 of "Building Insulation Guide"[9], the "Building Insulation Guide" also define how to present calculation of energy efficiency building.

3.3 Minimum energy performance requirements of the Building Ordinance ΚΔΠ 446/2009

This ordinance is adopted pursuant to Article 15 (1) of the "Regulation of Energy Performance of Buildings of 2006" (N142i 2006) and entered into force since 1st of January 2010. Under this ordinance, the minimum requirements for a building's energy performance (insulation requirements for each new building and each building renovation of a total useful floor area over one thousand square meters) are as follows:

Table 1: Insulation requirements

	U (W/ m^2K)
External walls and construction of the load bearing elements (columns, beams and walls) that are part of the building envelope. May overlap the U for thermal storage walls in case of use of passive solar systems.	0,85
External horizontal structural elements (floors exposed to the external environment-in flats or in-overhang, rooftops, roofs) and ceilings, which are part of the building's envelope.	0,75
Floors over non heated closed basement or semi-basement space	2,0
External frames (doors, windows) that are part of the building shell (note: excludes shop windows).	3.8
Maximum U shell except floor room and roof which constitute part of the shell : a) Building used as houses b) Building	 1.3 1.8

3.4 Energy efficiency of buildings (inspection of air conditioning systems-ΚΔΠ 163/2009)

For the purpose of reducing energy consumption and to reduce the carbon dioxide emissions, the owner shall ensure that the relevant work is done by a building services inspector who has submitted to the competent authority a written statement that:

1. has paid the relevant fee
2. he/she is a mechanical engineer registered with the Cyprus Chamber of Engineers (ETEK) or in the corresponding body of another E.U Member State with 3 years relevant experience
3. holds an examination passing certificate organized by an evaluation organization

Table 2: Inspection of Air conditioning systems

Air conditioning systems subject to inspection
1. Air conditioning systems with an effective rated output of more than 12kWh
2. Air conditioning systems with a nominal aggregate power in a building more than 50kWh

[9] http://www.mcit.gov.cy/mcit/mcit.nsf/All/E074577C58AD9EFCC22575B60047BEA8/$file/Methodology%20for%20Assesing%20the%20Energy%20Performance%20of%20Buildings.pdf.pdf

3.5 Energy efficiency of the building (inspection of air conditioning systems: ΚΔΠ 413/2009)

The methodology of inspecting air conditioning systems is described in the "Guide for inspections of air conditioning systems". The document describes the required data that must be gathered, the checks that must be performed and the guidance on the recommendations.

Table 3: Inspection of Air conditioning systems

Air conditioning systems subject to Inspection			
Categories of installations	Air conditioning systems of an effective rated output more than 12 kW and less than 250 kW	Air conditioning systems of an effective rated output equal or more than 250 kW	Air conditioning systems of nominal aggregate effective rated output exceeding 50kW
Frequency	The first inspection should be completed no later than the 31st of December 2011 or five (5) years after the date of the system's installation and then once every five (5) years	The first inspection should be completed no later than the 31st of December 2010 or three (3) years after the date of the system's installation and then once every three (3) years	The first inspection should be completed no later than the 31st of December 2010 or five (5) years after the date of the system's installation and then once every five (5) years

3.6 National Action Plan for Energy Efficiency (under Directive 2006/32)

Directive 2006/32/EC on energy end-use efficiency and energy services, sets the framework for implementing energy saving measures, to achieve the national indicative energy savings target. Local and regional authorities are critical for the successful implementation of this Directive, they should be consulted and involved, as and when appropriate in accordance with applicable national legislation, on planning issues, the development of programmes to provide information, training and awareness-raising, and on the implementation of this Directive at national or regional level. Such consultations may also serve to promote the provision of adequate guidance to local planners and building inspectors to carry out the necessary tasks.

Under the European Directive, in June 2007 Cyprus has submitted to the European Commission, a National Action Plan which adopts a national indicative target for energy savings equal to 10% of the average final consumption by 2016. To achieve the above objective, Cyprus must reduce annual energy consumption by 1.1% between 2008 and 2016.

3.6 Law 185(I) 2007 about the definition of requirements for the ecological design of energy using products

Directive 2005/32/EC is a framework directive and provides for the establishment of ecological design requirements (environmental aspects) which must be satisfied by energy-using products and which are covered by implementing measures so that they can be placed on the market and put into operation.

The harmonization of the Republic of Cyprus was done on December 13, 2007 by the Law "On the setting of ecological design requirements for Energy Product Act of 2007" (N.185(I)/2007).

The purpose of the law and regulations was to establish the requirements that energy-using products must satisfy, protected by implementing measures so that these products can be marketed or put into service in a way contributing to sustainable development through increased energy efficiency, to the level of environmental protection and to simultaneously increase the security of energy supply.

This is a framework law and includes several categories of products that consume energy. At this stage it established implementing measures for:

- ✓ Household electric refrigerators, freezers and their combinations (ΚΔΠ 615/2007),
- ✓ New Hot Water Boilers fueled by liquid or gaseous fuels (ΚΔΠ 630/2007) and
- ✓ Ballasts for fluorescent lamps (ΚΔΠ 621/2007).

The European Commission prepared a work plan for the product groups which have priority in implementing measures. At this stage there is a discussion about reducing energy losses in areas such as:

- electrical house and office equipment on standby or off function
- public street lighting
- home lighting
- external sources for the formulation and implementation of measures and in a final stage the adoption by member states under the Eco-design framework law

3.7 Draft regulations for the inspection of heating systems

There is a new regulation for approval about the inspection of heating system using boilers

Heating systems using boilers subject inspection
1. Heating systems with boilers of nominal effective output of more than 100kW.
2. Heating systems with gas boiler of nominal effective output of more than 100kW.
3. Heating systems with boilers of nominal effective output of more than 20kW, which are older than fifteen (15) years.

3.8 Draft Decree for inspection system

Inspection of Heating systems using boilers	Frequency
Heating systems with boilers of nominal effective output of more than 100kW, except gas boilers.	The first inspection to be completed no later than December 31, 2010 and thereafter at least once every three (3) years.
Heating systems with a gas boiler of nominal effective output of more than100kW.	The first inspection to be completed no later than December 31, 2010 and thereafter at least once every four (4) years
Heating systems with boilers of nominal effective output of more than 20kW, which are older than fifteen (15) years	One and only time. For heating installations with boilers of nominal effective output of more than 20 kW which at the commencement of this Ordinance are more than fifteen years, a survey to be completed no later than December 31, 2011.

4. Construction in Cyprus

4.1 Cyprus geographical and weather profile

Cyprus is located in the eastern Mediterranean Sea, 97 km east of Syria and 64 km south of Turkey at an average of 35^0 north latitude and 33^0 east longitude, Cyprus is the third largest Mediterranean island, after Sicily and Sardinia, with a total area of 9.251 square kilometers. Comparatively to its small size, Cyprus has long coastlines that stretch to 778 kilometers. Like all Mediterranean countries, Cyprus shows very noticeable geographical and climatic features.[10]

In the lowlands the average sunshine hours for the whole year are 75% of the hours when the sun is over the horizon. In the summer, sunshine averages 11.5 hours per day, while December and January sunshine duration decreases to 5.5 hours per day. Even at the high areas of Troodos, the average sunshine during the winter months is approximately 4 hours/day, while in June and in July it reaches 11 hours/day.

The maximum sunlight (from sunrise to sunset) in Cyprus ranges from 9.8 hours /day in December to 14.5 hours /day in June, according to the Cyprus Meteorological Service[11], while the average daily solar radiation on a horizontal surface in Cyprus is estimated at 5,4 kWh/m^2.

4.2 Energy Profile of Cyprus

The utilization of solar energy is a viable option for energy production in Cyprus, as Cyprus has very high solar potential and all areas have plenty of sunshine throughout the year (the highest in Europe).

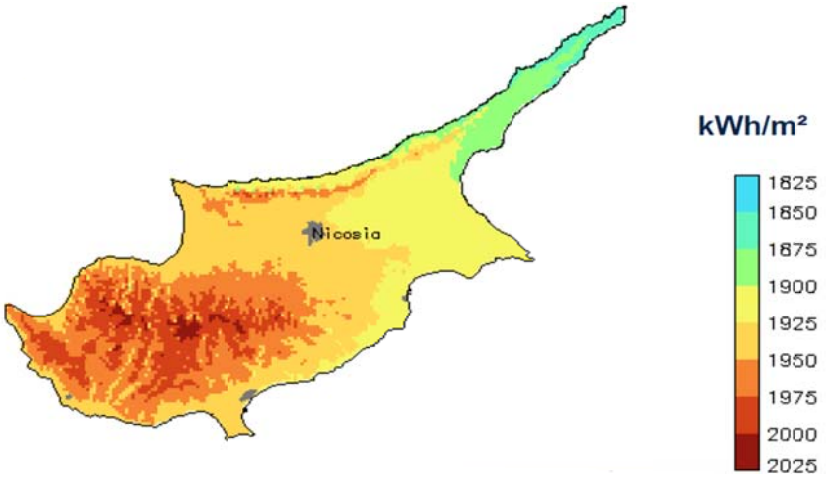

Figure 1: Yearly total of global irradiation received in Cyprus[12]

[10] http://www.mof.gov.cy 14-02-2012
[11] http://www.moa.gov.cy/moa/ms/ms.nsf/DMLindex_en/DMLindex_en?opendocument
[12] Manoli M 'REMOVE NON-TECHNOLOGICAL BARRIERS FOR TECHNOLOGY OF SOLAR AIR CONDITIONING IN THE ISLANDS OF SOUTHERN EUROPE'

4.2 Solar water heaters

Solar water heating (SWH) or solar hot water (SHW) systems comprise several innovations and many mature renewable energy technologies that have been well established for many years. SWH has been widely used in Greece, Turkey, Israel, Australia, Japan, Austria and China.

In a "close-coupled" SWH system the storage tank is horizontally mounted immediately above the solar collectors on the roof. No pumping is required as the hot water naturally rises into the tank through thermosiphon flow. In a "pump-circulated" system the storage tank is ground or floor mounted and is below the level of the collectors; a circulating pump moves water or heat transfer fluid between the tank and the collectors.

SWH systems are designed to deliver hot water for most of the year. However, in winter there sometimes may not be sufficient solar heat gain to deliver sufficient hot water. In this case a gas or electric booster is normally used to heat the water.[13]

The solar water heating systems appeared in Cyprus in the late 50's. In Cyprus there are about 35 small and medium-sized companies manufacturing solar water heating systems. The total annual production is approximately 30000m^2 of solar collectors.

Cyprus is the lead country in the world as to the per capita installed solar collector area and it reaches 1,01m^2 attributable per inhabitant. Today Cyprus has about 800000m^2 of solar collectors installed. The widespread use of Solar Water Heating Systems in Cyprus is due to:

1. The favorable weather conditions
2. The Cypriot manufacturers make high quality products.
3. The low solar systems effective cost.
4. The government provides technical support to the domestic solar industry
5. Inclusion in the sponsorship program of the Ministry of Commerce Industry and Tourism.[14]

Benefits of Using Solar Water Heating:

1. Saves 18.75 million annually (30 US $ / barrel).
2. Reduction of CO_2 emissions to the environment and avoidance of 10% of CO_2 emissions from burning HFO to produce electricity.
3. The "solar" industry employs approximately 500 people[15]

[13]www.wikipedia.org 13-02-2012
[14]Manoli M 'REMOVE NON-TECHNOLOGICAL BARRIERS FOR TECHNOLOGY OF SOLAR AIR CONDITIONING IN THEISLANDS OF SOUTHERN EUROPE'
[15] www.cie.org.cy/ 10-02-2012

4.3 Photovoltaic (PV)

Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material.[16]

In Cyprus, the first PV System which powered 4,84 kW was connected on the 17-02-2005. By the year 2011 the installed capacity of PV grid-distribution system to the EAC[17] amounted to 9329 kW while the total electricity production connected to the network was 10.138.950 kWh[18].

There is presently increased interest and activity for the installation of more production capacity both for the small systems and for the large systems. A number of companies are offering their systems on the market. The installation is subject to regulation as it is funded by the special Renewable Energy Levy imposed on all electricity users through their electricity bills.

4.3.1 Laws and Orders

For the installation of PV in Cyprus there are three law settings:

1. Order No. 2 of 2006 the Department of Town Planning under Article 6 of the Town and Country Planning Act (19 April 2006).

2. Circular No 3/2008, by the Department of Town Planning for the installation of PV systems for which no planning permission is required (13 May 2008).

3. The amendment of Order 2/2006 (19 March 2009).

Circular 3/2008, which followed Order 2/2006, specifies the cases for the installation of PV systems (either on structures or on the ground), which fall within the term "minor work" and does not affect substantially the exterior of the building. For small installations, it is not necessary to submit an application to the Planning Authority, if the following conditions are valid:

A. Installation on a legally existing building:

• The installation is done on the roof or at another part of the shell
• The modules be organically and harmoniously integrated into the building shell
• The building has not been declared an ancient monument or is listed in:

- a controlled area by the Antiquities Department
- an archaeological protection zone
- a special airport zone.

• Placing PV system on an inclined roof all modules must be touching each other, except in the case of buildings with two or more southern sloped roofs. The slope of the roof should be from 14^{o} to 45^{o}.

[16] www.wikipedia.org 13-02-2012
[17] Electricity Authority of Cyprus AHK
[18] www.cera.org.cy 22-02-2012

• If mounting the system on a horizontal roof, the height of the frames should not exceed 1,20 m from the end of the roof, the frames, should be placed in uniform parallel lines and must be separated from the edges of the roof by a distance at least equal to the maximum height of frames. In addition, in the case of accessible, padding roofs, should be placed a immurement with a minimum height of 1,10 m.

B. Installation of a photovoltaic system on the ground on a plot in which there is a lawful building:

• The system should be small, up to 20 kW and designed to fill the energy needs of the building.
Also, according to the amendment of Order 2/2006, photovoltaic generation or solar thermal installation elements will not be counted in the building factor and in the amount of coverage, specified for the Planning zone where the facility is located.

4.3.2 Motivation and sponsorships plans

The installation of photovoltaic systems in homes is sponsored from the Grant Scheme of Energy Saving and encouraged by the Renewable Energy 2009-2013 Acts of the Ministry of Commerce, Industry and Tourism. Each person who wishes to invest in a PV facility system up to 20 kW connected to the Cyprus Electricity Authority's Power Grid, under the existing Grant Scheme (July 2010) can choose between two options:

Option 1:

Grant 55% of the eligible costs (maximum sponsorship €33.000)

Subsidy for each kWh sold to the Network with a total value of 22.5 cents/kWh (22.5 cents/ kWh subsidy - price EAC).

Option 2:

Subsidy for each kWh sold to the Network with a total value of 38.3 cents/kWh (38.3 cents/kWh subsidy - price EAC)

For stand-alone PV systems (up to 20 kW non-connected to the EAC network) there is only 55% funding of the eligible costs (maximum grant amount of €44.000).[19]

[19] http://www.eac.com.cy 15-02-2012

4.4 Insulating building materials

The heat loss or gain in a building is caused by the transmission of the heat in the air from the interior to the atmosphere or to the surrounding cooler areas or the reverse. The thermal insulation of buildings slows the speed of the heat exchange through the surfaces (walls, roofs, floors, windows) in separate areas or rooms at different temperatures. The insulation in a building, practically provides a protective shell, which slows heat transfer from and to the inside the building.[20]

According to Law (N.142 (I)/2006) for the energy performance of buildings, the Ministry of Commerce, Industry and Tourism adopted supporting programmes in order to promote and extend the use of insulation materials in the construction field. Within this Law, a grand scheme titled "Saving energy with new investments in private building units", is announced by the Ministry, which allows each individual owner of a building unit, to receive funding in order to apply thermal insulation materials. Acceptable applications refer to insulation of both existing and new buildings. According to the terms of this scheme, a subsidy equivalent to 30% of the eligible cost of the investment is provided to individuals, whereas the maximum amount available for each building unit is €1700.

Furthermore, different kinds of materials are used for insulating floors, walls and roofs, in different regions of the island. Therefore, the majority of the applications only referred to one insulating measure, mainly the double glazing, neglecting other possible insulation works which may have to be carried out. Comparatively, in Europe the most extensively used insulating material is stone wool (35%), whereas, in Greece expanded polystyrene is mostly used (48%). This comparison indicates that in Cyprus there might be poor know how and certainly lack of experience regarding the options of thermal insulating materials. Additionally, the local industry that produces insulating materials is small thus most of the materials used are imported and their cost might be significantly higher.[21]

Cyprus industries and the import companies have changed their products so they will harmonized to the Cyprus and European law about energy performance of building. For example they produce or import:

- ✓ aluminum and PVC frames for double glazing
- ✓ thicker glazing
- ✓ larger bricks
- ✓ Insulating bricks

4.5 Solar

4.5.1 Passive designs and bioclimatic architecture

The bioclimatic approach aims at re-establishing the links of architecture with the principles of building techniques. This approach reduces or even eliminates the waste of energy in controlling the microclimate within a building. At the same time, it restores the contact of humans with nature, the idiosyncrasy of a place and the quality of life. In Cyprus, bioclimatic architecture may apply to the climatic conditions over the entire year. In addition, the year-round sunlight and the high solar radiation make the need for exploiting solar energy even more mandating.

[20] http://www.cie.org.cy 16-02-2012
[21] S. A. Kalogirou *et all* 'Classification of buildings in Cyprus based on their energy performance' 2008

4.5.2 Cooling and solar/air conditioning

Solar-heated air can be used in a wide variety of applications, but it is a limited resource. Only so much sunshine strikes each square metre of the earth, and a well-built collector system will typically deliver about half of this energy to a house in the form of heat. The way this heat is used often means the difference between a useful, cost-effective system and one that never seems to perform properly. Effective use of collected solar heat is especially important in retrofitted systems which, because of space limitations, are often undersized for the houses they are serving.

4.5.2.1 Convective Air Heaters

Maintaining a continuous flow of low grade heat is the goal of any convective air heater design. A properly built passive air heater will raise the temperature of the air moving through it by almost 45°C. This low-grade heat enters the house very slowly through large openings, and the air movement is hardly noticeable, thereby heating the home in a very comfortable way. Only very few systems apparently exist in Cyprus and there is great scope for retrofits and improvements.

4.5.2.1 Active solar air-heating systems

Active solar air-heating systems are more versatile than convective systems because they allow the direction of the heat to rooms that aren't near the collector. Active systems can be more expensive to build than passive systems, but they are easier to design because of their forced-air operation. With forced-air systems there is less concern about designing to maintain delicate natural convection airflow. Finally, active systems have often demonstrated better performance than their passive counterparts, delivering more heat per square foot of collector. Also only very few systems apparently exist in Cyprus and there is great scope for retrofits and improvements.

4.6 Other

Compact Fluorescent Efficiency lighting: These lights are a huge advance in energy efficient lighting with 10 times longer life than an incandescent bulb. Plus, the light quality (colour temperature) is much warmer than normal fluorescents, they fit in most normal light fixtures, and flicker is hardly noticeable.

Dimmer switch: A handy electrical component that lets one adjust light levels from nearly dark to full light by simply turning a knob or sliding a lever.

Smart Relay Switch: Automatically shuts off air conditioning or heating when a monitored door or window remains open for a period of time.

Motion Sensor Light Switch: Only turns lights on in a room when it is occupied. By automatically turning off the lights when no one is in the room, the manufacturers claim that an average of 128 hours per year of unnecessary lighting will be avoided, reducing electricity consumption for the lighting by 10%.

Other energy efficient materials devices and equipment are continually introduced in the market as they become available.

Local research for further uses of solar energy in buildings and industry is active both at University level and in private research firms.

5. Training and awareness

In Cyprus the government and the involved community are placing great attention into the training and the creation of awareness of energy inspectors, the public and industry.

Special seminars are organized by the Department of Energy, the Cyprus Chamber of Professional Engineers (ETEK) and the Cyprus Energy Institute on:

- energy efficiency in buildings
- energy saving modes in relation to buildings
- any new technologies that have been introduced relating to energy efficiency in buildings,
- public awareness about the necessity of saving energy for environmental and also for economic reasons

There is also an annual Exhibition on Environmental and Water Technologies which incorporates energy related products and services.

6. Conclusions

Cyprus is following the rest of the world and the European Union in particular on the path to better energy performance overall. The building sector is only but one aspect. Driven mainly by legislation, but recently also by escalating energy costs, consumers are changing their behavior in relation to energy efficiency. The market is responding to demand and is introducing new and improved materials while the scientific community is actively engaged in retraining and awareness creation programmes. The effort to create awareness needs to be intensified while the culture must also change so that the consumers and the engineers get out of the “ROI trap”.