Low energy building design using Renewable Energy Sources

By Petros Kronis
Mechanical Engineer and Research Engineer, member of ETEK
petros.kronis@gmail.com
www.kronis.tech

The recent heat waves which even managed to close schools, bring to light the condition and unsuitability of buildings in Cyprus.

Around 40% of the energy consumed in the EU is used in buildings. More than 1/3 of the EU's energy-related carbon dioxide emissions come from buildings. 80% of the energy used in EU buildings is used for heating, cooling and hot water.

For a building to be useful and comfortable for its occupants, it should offer the following: **1) Thermal comfort**, with the right temperature, humidity and air circulation. **2) Air quality** with adequate ventilation and filtration to ensure clean air. **3) Visual comfort** with natural and artificial lighting appropriate to the use of the premises. **4) Acoustic comfort** with sound insulation and noise control, and **5) Ergonomics** with furniture and equipment that support user comfort and performance.

In the old days, before the advent of electricity and cheap fuels, architects of the time knew how to use passive energy methods to provide comfort in buildings. Today, passive energy methods, while still useful and necessary, are further enhanced by the adoption of new technologies. These passive methods use the following: **1) Proper orientation of the building** to allow solar energy to enter in the winter for heating, and to prevent this energy from entering during the hot summer months. This is done by architectural features such as overhangs and pergolas, but also by trees and plants that provide natural shading. **2) Good insulation** to reduce thermal energy lost during the winter season or entering the building's spaces and is unwanted during the summer period. **3) Ventilation** by replacing indoor air with fresh air, a necessary condition for a healthy environment inside a building. In the old days this was done without filtration which is not appropriate today due to increased levels of dust and exhaust gases in the atmosphere. **4) Glass panes**, using high performance glass to manage solar energy. In addition to being treated to control the input of thermal energy where it is not desired, these glasses can even generate electricity by incorporating photovoltaic cells. **5) Thermal mass** using materials that absorb and store thermal energy within the building for use during the winter season.

Unfortunately, with the advent of electricity, architects stopped dealing with passive energy methods and focused on the exterior and interior design of buildings. Heating and cooling were left to be achieved by electricity and liquid and gaseous fuels, resulting in the indiscriminate use of large amounts of energy from non-renewable sources which is causing the global climate crisis.

With these facts we have inherited today in Cyprus a building stock that needs transformation to be useful, efficient, ecological and comfortable. Even today, new buildings are appearing which completely ignore the standards and timeframes set by the European Union and other countries, even for buildings with zero energy needs (e.g. EU Directive on the energy efficiency of buildings (EPBD) (EU/2024/1275). We seem to believe that we have plenty of time until 2030 and 2050. All the state has done regarding the energy efficiency of buildings was to legislate to improve the insulation of the masonry.

Another technology that not only can but must be used to cool spaces in hot and dry climates such as ours during the summer months, is that of evaporative cooling. The basic principle of evaporative cooling is the fact that a liquid, when it evaporates, absorbs energy from its environment. Evaporative coolers take advantage of this fact to cool the air by evaporating water. One kilogram of water, when evaporated, requires 2256 kJ of energy, which it absorbs from the environment, resulting in cooling. Evaporative coolers can reduce the air temperature by up to 8^{o} C. Direct type chillers also increase the humidity of the air which is not suitable for indoor spaces but there are indirect type chillers that avoid the increase in humidity and others with increased efficiency. The evaporative cooling method can be combined with air filtration technologies. HEPA air filters can remove at least 99.97% of dust, pollen, mould, bacteria and any airborne particles as small as 0.3 μm.

Now compare the evaporative cooling method that could provide school classrooms with a continuous flow of 100% clean and cool air, with the one we have heard proposed in the last two years (of split unit air conditioners), which recycles the same indoor air, while allowing its pollution to increase, providing only cooling, with huge in comparison electricity consumption.

An example of a building design using low-energy green methods as described above is that of the Visitor Centre at Zion National Park in the USA. For those interested, details of the building's energy efficiency here: https://www.nrel.gov/docs/fy05osti/34607.pdf