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Achieving nearly zero energy buildings in Cyprus, through building performance simulations, based on the use of innovative energy technologies

Marina Kyprianou Dracou[a]*, Mat Santamouris[a], Costas N. Papanicolas[a]

[a]*The Cyprus Institute, 20 Konstantinou Kavafi Street, 2121 Aglantzia, Nicosia, Cyprus*

Abstract

In Europe, 27% of final energy use occurs in residential buildings and another 14% in tertiary buildings, making the "building sector" the largest end-use energy consumer with over 40% of the total. The energy consumed within European buildings averages to 70-230 kWh/m^2 per year. Achieving a nearly zero energy (NZE) target in buildings is both necessary and crucial.
This paper presents the methodology and initial findings from modelling and simulating advanced energy conservation and generation technologies in two case study buildings in the area of Peyia, Cyprus. The simulations were performed through free-running and thermostatically-controlled conditions by means of Design Builder software, in order to achieve the nearly zero energy (NZE) target. The specific objectives are both a reduction of the net regulated energy to an average of 0-20 kWh/m^2 per year, as well as a generation of at least 50 kWh/m^2 per year in each building. The findings of the study are that the nearly zero energy target is achievable if a majority of the energy used in the buildings comes from renewable energy technologies and if the regulated loads of the buildings are reduced through the use of energy conservation technologies.

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Keywords: Nearly zero energy, simulations, innovative technologies, energy conservation, energy generation

1. Introduction

Globally, buildings consume over one third of all final energy and half of all electricity, and as a result they are also responsible for about one third of global carbon emissions [1]. The European Union has established specific policies aimed at reducing fossil fuel consumption and their related greenhouse gas (GHG) emissions. The Europe 2020 strategy adopted by the European Commission stipulates three targets to be met by the year 2020: a reduction in GHG

* Corresponding author. Tel.: +35722208713;
E-mail address: m.kdracou@cyi.ac.cy

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emissions of 20%, an increase in energy efficiency of 20%, and an increase in the contribution of renewable energy sources equivalent to 20% of final energy consumption, in relation to those of 1990. By simultaneously reducing consumption and relying on "clean" production, all new buildings will be "nearly" zero-energy. Practically, this means that energy consumption decreases over time and is eventually matched by an equivalent supply of energy from renewable sources (see Figure 1). Net zero-energy buildings (NZEB) are thus intended to have very high energy performance, and the low amount of energy that they require comes from sustainable non-fossil resources. According to one recent definition by Voss et al. [2], "Net Zero Energy Building" describes the "synergy of energy efficient building and renewable energy utilization to reach a balanced energy budget over a yearly cycle." Member countries are directed to establish their own schemes for setting and achieving specific performance requirements for buildings and related systems.

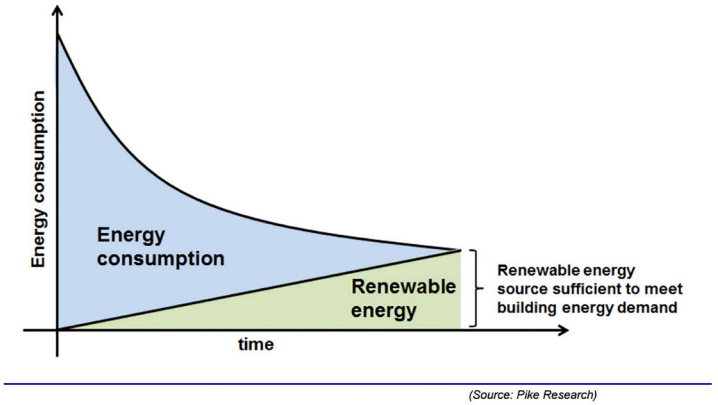

Figure 1. The net zero-energy building concept, by which energy consumption decreases over time and is eventually matched by an equivalent supply of energy from renewable sources, according to Bloom & Wheelock [3].

The study in this paper is part of a major Horizon 2020 research project, with case studies in the UK, France, Italy and Cyprus, on design, optimisation, implementation and monitoring of advanced and cost-effective solutions for achieving nearly zero energy (NZE) and positive energy settlements. The present paper presents and analyses the results of early modelling and simulation of two case study buildings which are a part of a settlement to be built in the area of Peyia, Cyprus. The buildings are estimated to be built by summer 2018. The specific objectives of this study are to achieve:

- A reduction of the net regulated energy to an average of 0-20 kWh/m^2 per year through the application of a number of energy conservation technologies.
- A renewable energy generation of at least 50 kWh/m^2 per year on average in each building through either building integrated and/or community renewable systems.

The project targets are only focussed on regulated energy consumption.

Nomenclature

RE	Regulated energy = space heating + cooling + ventilation + domestic hot water (DHW) + fans + pumps
RES	Renewable energy = Energy production from building level and community level renewables.
NRE	Net regulated energy = (RE) – (RES)

1.1. The case study

The settlement is located in the western part of Cyprus, near the town of Peyia (Paphos) (34°89′N and 32°38′E). It is in a rural area on a hillside location, with slope of a medium-steep 20-30% (see Figure 2). The climate in the area is intense Mediterranean, with mild winters and hot summers (Tmax 36°C, Tmin10°C). The settlement size is 255,000m², and it is divided in 3 areas: a rehabilitation center, a research center and a residential area. The residential part of the development includes 95 individual houses and 9 apartment buildings. Under Zero Plus project 2 houses