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Perspectives of energy efficient technologies penetration in the Greek domestic sector, through the analysis of Energy Performance Certificates

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HIGHLIGHTS

- Energy Performance Certificates reveal market trends of energy efficient technologies.
- SWH, replacement of windows and walls/roof insulation are most often recommended.
- Other measures are controls, switch to NG; low cost measures are rarely recommended.
- Cost-effectiveness is not the main factor explaining technology recommendations.
- Amendment of EPC document and inspection process may enhance its effectiveness.

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ABSTRACT

The building sector in Greece presents a huge energy saving potential, the largest part of which is remaining unexploited. The recently enacted legislation for the energy performance of buildings, in combination with the financial support provided by funding programmes to low income families is expected to significantly boost the deployment of energy efficient technologies in the Greek domestic sector. The exploitation of these legal and financial instruments follows a formalised process of energy audits, resulting in buildings classification and in the submission of Energy Performance Certificates (*EPCs*) including suggestions to improve the dwellings' energy performance. The paper aims at an ex-ante evaluation of the market trends revealed by *EPCs* in Greece, in order to identify the perspectives of individual technologies and to assess the degree to which the certification procedure helps in improving the energy performance of buildings. The results indicate a strong trend towards less cost-effective technologies, revealing a sub-optimal allocation of financial resources and putting into risk the path towards the achievement of EU targets for 2020.

1. Introduction

Policy makers in the European Commission have agreed that there is an urgent need to adopt energy efficiency measures in order to comply with the energy and climate targets set for 2020, including the commitment to reduce by 20% energy consumption compared to the projected consumption in that year. Buildings account for 40% of total energy consumption in the EU, therefore they are central in energy efficiency programmes.

The situation is similar in Greece, where the domestic sector, not including buildings of the tertiary sector, represents 24% of the total final energy consumption of the country (YPEKA, 2012a). It should be emphasised that a large part of the final consumption in the domestic sector is electricity (32%), with the majority of the rest (45%) being oil products (see Fig. 1). The renewables share refers mainly to biomass (mostly wood used in fire-places or ovens) and solar energy used for domestic hot water (DHW) production.

Although the per capita domestic energy consumption in Greece is approximately by 25% lower compared to EU average

Abbreviations: AC, air conditioner; CHP, combined heat and power; DHW, domestic hot water; EPBD, energy performance of buildings directive; EPC, Energy Performance Certificate; HDD, heating degree-days; IEC, indirect evaporative cooling; LPG, liquefied petroleum gas; NG, natural gas; SH, "Saving at Home" programme; SH-EPC, EPC edited in the frame of SH-programme; SWH, solar water heating; TIR, Thermal Insulation Regulation; TRV, thermostatic radiator valves; VSD, variable speed drive; O.G.H.R., Official Gazette of the Hellenic Republic; O.J., Official Journal of the European Union; T.O.T.E.E., technical guide (T.O.) edited by the Greek Technical Chamber (T.E.E.)

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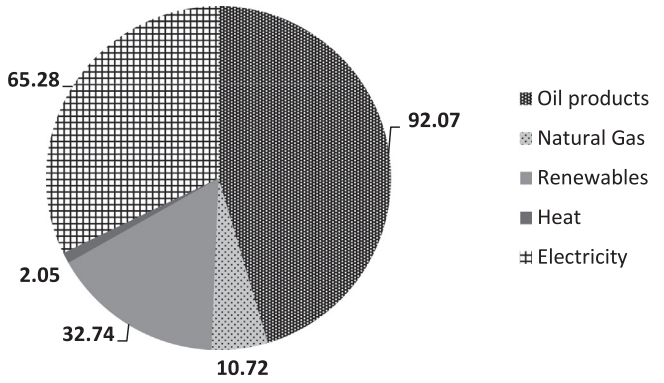

Fig. 1. Distribution of final energy consumption in the domestic sector of Greece (values in PJ).
Source: YPEKA, 2012a.

figures, there is strong evidence that energy use in Greece is less efficient, because of the mild climate conditions inducing lower energy requirements for space heating which is responsible for the largest part of total energy consumption in the domestic sector.

The penetration of energy efficient technologies into the domestic sector usually takes place as a combined result of several factors. Household income, energy prices and consumers behaviour are generally considered as being the primary determinants of both, fuel expenditures and investment on energy efficient technologies. However, for a certain level of these parameters, the characteristics of the building (location, orientation, age, design etc.) may significantly influence energy performance and thus, the financial attractiveness of energy efficiency technologies. In addition, personal attributes, such as ownership, age, education, environmental awareness etc., are also found to affect the adoption of individual technological solutions (Nair et al., 2010).

The severe economic crisis of the last 4 years had a substantial impact on the penetration of energy efficient technologies in Greece. Greek households have seen a dramatic decline in their income, following the drop of the Greek GDP by 22% since 2008. On the other side, the construction sector was severely hit by the recession. The drop in the building activity reached 37% in 2012, compared to 2011.

Under these conditions, the European Directive 2002/91/EC for the Energy Performance of Buildings – EPBD (EC, 2003), adopted by the Greek State since 2008 and enacted in 2010, after the completion of the complementary legal actions and technical guides, represents a big challenge to decrease energy consumption in Greek buildings.[1] At the same time, EPBD offered the opportunity to reactivate the construction sector.

In order to support the implementation of the EPBD, a funding programme entitled "Saving at Home" (*SH*) was launched in 2011, providing subsidies to low-income households. Nevertheless, due to the economic crisis, participation in the programme was rather limited, as approximately only 10,000 applications had been approved during the first year. As a consequence, it was decided to slightly relax eligibility criteria concerning households' income and buildings classification, in order to include a larger number of potential beneficiaries. In fact, this modification, together with a rise in energy prices stimulated increased participation rates, reaching 2000 applications per week.

Certification is a crucial element of the EPBD and is intended to secure transparency in the calculation of the energy performance of buildings by independent energy experts, using a prespecified and transparent methodology. Specifically, Energy Performance Certificates (*EPCs*) are expected to assist in the diffusion of energy efficient technologies in two ways:

- Through the classification of buildings to specific energy performance categories, since a higher energy class may lead to a higher rental or selling price of the building/apartment.
- Through the recommendations included in *EPCs* on cost-effective ways to improve the energy performance of the building/apartment, that may enhance awareness of owners.

The first *EPC* was issued in Greece in Jan 12, 2011 and details on the document are given in Dascalaki et al. (2012). A total of almost 200,000 *EPCs* have been issued since then, and relevant statistics are already available (YPEKA, 2012b), although they do not provide any technical details.

The question still floating around is on the degree to which the implementation of EPBD is able to meet the prescribed minimum energy performance requirements. The scope of the present paper is to systematically investigate *EPCs* by focusing on the type of the recommended interventions. The performed analysis is intended to identify the most commonly suggested energy efficiency measures and to assess their cost-effectiveness.

Following this introduction, Section 2 proceeds to the classification of energy efficiency measures with respect to their cost-effectiveness on the basis of a systematic literature review, Section 3 gives basic information on *EPCs* and Section 4 describes the sampling and analytical procedure followed. Finally, Section 5 presents and discusses the obtained results, while the conclusions drawn are included in Section 6.

2. Review and classification of available energy efficient technologies in Greece

A vast variety of measures aiming to increase energy efficiency in buildings and/or save natural resources are today commercially available. Energy inspectors are called to identify and recommend the most appropriate interventions for the cost-effective improvement of the energy performance of the building or apartment under inspection. It is clear, that the technical performance of each measure may vary significantly depending on the following major factors:

(a) The geographical location of the building.
(b) The particular characteristics of the building, such as orientation, year and mode of construction.
(c) Technical details of the equipment used and operation mode.

In addition to the above characteristics, financial attractiveness is also influenced by macroeconomic parameters, especially fuel and electricity prices, feed-in-tariffs (for photovoltaics), interest rates etc., as well as by the cost of equipment and labour costs.

In Greece, the geographical location is supposed to play a decisive role in the selection of the appropriate measures, since as shown in Table 1, heating degree days (HDD) vary significantly in the four climatic zones of the country. For example, wall insulation is highly cost-effective in the colder climatic zones *C* and *D*, while presenting only a marginal profitability in buildings located in zone *A*.

In order to proceed to a comparative evaluation of energy efficiency measures, they have been classified in the following broad categories according to their primary scope of application:

- Building envelope measures (E): applied to existing buildings in order to reduce heating and cooling loads by minimising heat exchange between indoors and outdoors

[1] The new Directive 2010/31/EC on the Energy Performance of Buildings (EU, 2010), repealing the Directive 2002/91/EC, was only recently transposed into the Greek Legislation, but is not yet enacted.