Research of energy behaviour and energy poverty of households in Northern Greece

S N Boemi1, M Samarentzi2, A Dimoudi2

1 Aristotle University of Thessaloniki, Department of Mechanical Engineering, Thessaloniki, Greece
2 Democritus University of Thrace, Department of Environmental Engineering, Xanthi, Greece

Abstract. The present paper examines the phenomenon of energy poverty in Greece. Specifically, energy poverty concerns a growing number of households that have limited access to energy or are unable to pay for this energy, mainly due to insufficient thermal insulation, low income and high energy costs. The continuing economic crisis in Greece has increased the rate of energy poverty as incomes have fallen, the price of oil and PPC tariffs have risen, more households are asked to pay more than 20% of their energy bill income. Excessive energy poverty in turn has an impact on the environment (illegal logging, smog, etc.), but also to the physical and mental health of people exposed to it. The paper includes a case study which provides information and data collected from a sample of 384 households using the questionnaire method in four areas of northern Greece, which is the Edessa area in Central Macedonia, the area of Drama in Eastern Macedonia, the area of Xanthi and the Municipality of Myki (Pomakohoria) in Thrace. Initially, personal data, housing characteristics and household health status are presented. The types of heating system of the examined households and the extent to which they meet the required levels of thermal comfort are presented below. In addition, the aforementioned data is associated with the energy accounts. The findings, show that energy poverty has affected a significant proportion of households in Greece. This is due to the fact that there are households that do not meet the energy needs of their home.

1. Introduction

The backbone of a modern economy is the secure and affordable supply of energy to consumers, which can be considered as part of the emerged social science research agenda of Energy Justice. Therefore, energy poverty concerns the European political agenda not only as an energy-related concern, but also as a broader social issue touching on many related areas like healthcare management and climate change policies [1], [2]. Energy and climate change policies also influence energy bills, with low-income households being over-proportionally affected by growing energy prices and related expenses. Researchers argue that European Union (EU) and national policy addressing climate change can be used to combat energy poverty via improved domestic energy-efficiency measures [3], [4].

Energy poverty is linked to low household income, high energy costs and energy inefficient homes, and is known to have severe impacts on the health of EU citizens, including increased numbers of winter or summer deaths, detrimental effects on mental health, respiratory and circulatory problems. Existing approaches for the definition of the phenomenon are based on quantitative indicators, such as the proportion of household expenditure on energy bills in relation to their income or the latter’s relation to the poverty line after subtracting the cost for energy services (the 10% approach, ‘low income – high costs’, ‘minimum income limit’), and qualitative indicators (consensus approach). Moreover, research have been done on the factors behind energy poverty [5]. The results show that energy poverty is caused by different factors, including socio-demographic characteristics and housing characteristics [6], [7], [8]. However, the results in this area are heterogeneous and ambiguous [9].

In 2016, 44.5 million people were unable to keep their home warm and 41.5 million people had arrears on their utility bills [10]. One of the objectives of the EU strategy is to reduce by at least 20 million the number of energy poor citizens [10]. In this respect, guidance and financial support to energy poor
citizens for implementing energy efficiency interventions and setting up energy cooperatives could facilitate their social integration and help them escape energy poverty. Central and Eastern European countries have Europe’s highest energy poverty levels. The vulnerability of citizens in countries, such as Bulgaria, Croatia, Estonia, Greece, Hungary and Latvia can be attributed to the legacies of the centrally planned economy, such as the poor thermal insulation properties of the housing stock, the presence of historically low energy prices and the predominance of an unsustainable supply mix [12].

But the phenomenon of energy poverty is of particular interest to Greece, given that more than 50% of the building stock in the residential sector was built before 1980 and has no insulation. Additionally, between 2010 and 2017, economic crisis and the austerity policies implemented has declined by more than 35% the average income of households [13]. At the same time, the increase of the prices of basic energy products used in households for space heating and other energy uses due to increases in excise taxes have created difficult living conditions [14].

In this context, the present paper presents a study from an in-situ survey about energy poverty in the regions of Eastern and Central Macedonia and in Thrace, Greece. Personal data, housing characteristics and household health status are included. The structure of this paper is as follows: Section 2 presents the methodological framework of the analysis, the structure of the questionnaire developed for measuring energy poverty. In Section 3, the methodology is applied in Eastern and Central Macedonia, and in Thrace, Greece, estimating energy poverty levels. Finally, in Section 4, the main findings of the study are summarized, and conclusions are drawn.

2. Methological Framework

2.1. The Survey

The analysis is made in the two wider regions located in North Greece, Eastern Macedonia and Thrace and Central Macedonia. According to the Greek legislation for energy efficiency in buildings, implemented, by means of the Regulation for the Energy Performance of Buildings (KENAK) [15], those areas belong to climate Zone C – the country is divided into 4 climatic zones. It’s the second coldest zone in the country with mild summers and average heating degree hours (HDD18°C) according to KENAK ranging from 1601 to 2200. As a result, the energy needs for heating are of the highest in Greece. Also, Papada and Kaliampakos [14], who attempted to measure energy poverty in Greece, found that colder climatic zones and higher altitudes, like the study area, are the ones with more vulnerable households. The coldest months are January and February, with the average minimum temperature between −5 and 5°C.

Four different locations / cities with similar socio-economic characteristics, but different citizen’s cultural characteristics, household particularities and religious, were selected: Xanthi, Drama, Edessa and Miki (Pomakochoria). The first two are medium sized cities with urban characteristics and the other two have sub-urban or even rural characteristics. All of them are located near mountainous areas. More than 75% of their population are professionally active according to the results of the 2011 census (84% Miki, 77% Drama, 82% Edessa, 75% Xanthi). Therefore, as already mentioned, Greece faces an economic crisis since 2008, and energy poverty levels have increased considerably as a result of implemented austerity policies. These trends are not that pronounced in smaller areas, due to the fact that more than one fourth of their active citizens are civil servants (5% Miki, 27% Drama, 24% Edessa, 28% Xanthi). The only exception of the sample is at Miki or else named Pomakochoria where their main economic activity is the cultivation and the primary treatment of tobacco.

The starting point of this analysis is the estimation of energy poverty levels based on an existing, widely used methodology, that includes three main components for energy poverty estimation ([13], [16], [17], [18], [19], [20], [21], [21], [23]). Those are low household income; high/growing energy prices and inefficient energy performance of buildings concerning thermal insulation, heating systems and equipment. Based on that, a survey of households in Drama, Edessa Xanthi and Miki was carried out, through an appropriately designed questionnaire, aiming at gathering all the necessary primary data to assess energy poverty based on the aforementioned components.
The survey was conducted between July 2017 and April 2018 via interviews. 384 questionnaires have been completed in total from 400 questionnaires (88 from Miki, 100 from Drama and 100, Edessa and 96 from Xanthi). There were no criteria for selecting the statistical population apart from their willingness to answer to our survey. To avoid any misunderstandings, the researcher had a close monitor of the procedure and the questionnaires. A protocol was established for monitoring the composition of the sample on a regular basis over the survey in relation to the targeted stratification. In case of discrepancies, researchers applied specific guidelines for the selection of the participants with the appropriate profile that will result in improving the representativeness of the sample. The selected data were subjected to quality control and those not satisfying the requirements were rejected.

The questionnaire was based on one distributed by Boemi et al.[25]. The initial configuration of the questionnaire followed a pilot application of 10 questionnaires in order to identify potential difficulties and problems, misunderstood questions, etc. The final questionnaire that was used included only closed simplified questions in order to the increased convenience of the questionnaires. It included information about energy consumption of households and their correlations with various socio-economic parameters. Specifically:

- Section 1 (11 questions) focus demographic and socio-economic characteristics of the households, allowing, among others, to ensure the representativeness of the sample.
- Section 2 (14 questions) focus on the characteristics of the residence and investigate its type (apartment or house), the year of construction, total floor area, the potential realization of energy upgrade interventions, privately owned or rented, etc.. Also, it requested data about space heating and cooling of the residence by recording the available heating and cooling systems.
- Section 3 (16 questions) focused on energy comfort. Thus data about the way in which they are used and to what extent satisfactory indoor thermal comfort conditions are achieved. In those questions, there were similar questions with the one included in the EU - Survey of Income and Living Conditions [24] as regards arrears on utility bills and housing faults, collect data on the energy expenditures made by households for purchasing fuels for their residence and for paying the electricity bill.
- Section 4 (6 questions) refer to potential health problems of the members of the household that could be attributed to poor indoor conditions and to what extent energy expenditures limit household's capabilities to acquire other basic goods.

3. Results

3.1. Profile of respondents

The age of the participants in the survey ranged from 18 to 68 years. Specifically, 83% of the population in Miki, Edessa and Drama belong to the productive ages between 18 - 59 years, while in Xanthi the same ages appear at 93%. About 59% of the respondents were male and 41.1% female. 57.7% of the sample were families in Xanthi, Edessa and Drama and 80.7% in Miki, 25.7% single-person households in Drama and Edessa, 36.5% in Xanthi and 11.4 in Miki. 4.8% were divorced while 7.0% widowers. The average number of persons per household is 3-4 (44.9%).

The poorest persons of the sample are from Miki. 74% have an average net-income below 10,000.00€. At the most other three areas more than the average sample have a net-income between 10,000,00€ - 30,000.00€ (Xanthi 60%, Drama 54% and Edessa 42%), fact that is closer to the national average which is 20,202 €. 59% of all respondents faced a net-income reduction in a range 0.00€ - 5,000.00€. Even though 83.5% declared that their salary is sufficient to cover their daily needs.

Concerning education levels, the higher percentage of educated people appear in Xathi were 43.8% of the participants have a University degree and 16.7% have a MSc degree and a PhD against 46% from Edessa and Drama that have finished secondary education and 56.8% from Miki that are illiterate or uneducated.

3.2. Household’s characteristics
About 54.5%, 83.3%, 45.1% and 72% of the participants in Miki, Xathi, Drama and Edessa, respectively, respectively lived in multi-dwelling buildings. Also, more than half of the dwellings were privately owned (87.5% Miki, 49.0% Xathi, 76.5% Drama and 79% Edessa). Most of the sample at Miki (44.3%) and Drama (51%) of the respondents, resided in dwellings of 100-150m², and from Xanthi (43.8%) and Edessa (48%) lived in smaller dwellings with floor area of 50–99m², while the corresponding national average is close to 85 m²[25]. Only 4.8% of the sample have a space over 150m².

As regards the age of buildings, 56% of the sample resided in dwellings that were built between 1980-2006, after the 1st Thermal Insulation Regulation came into force in Greece and are therefore considered to low-insulated. Only 26% of the sample live in buildings before 1979, which can be considered uninsulated.

Moreover, the results of the survey unveiled various characteristics of the domestic heating demand. Particular, regarding the heating system used, 48.3% heated with oil system alone in Edessa, Xanthi and Drama while in Miki only 8%, where the main heating system is wood stone with 65%. About 52.6% of the households heated the total floor area of their residence, even though 42% consider their heating system sufficient (figure 1) and 48.2% succeed to maintain the temperature inside the house. The results unveil a perception issue about what is energy poverty.

![Figure 1. Satisfaction from the heating system.](image)

### 3.3. Health

The main question concerned the Health problems that can be attributed to poor indoor conditions. The respondents declared that their overall health is good enough. More than 74% of the sample in all areas indicates there is no family health problem. Compared to the national data, there are discrepancies, compared to people whom declared that they have a health problem. From the 17% responded that they have a health issue while the national average is 4.2%. That appears due to the fact that a large percentage of retirees and ages 60 are included at the sample. 90% of questioned households declare that there is no individual in their family or they themselves that have a disability problem. Finally, 60% of the respondents said that there is no problem of allergy in their family.

### 3.4. Measurements of energy poverty

Energy poverty is about the ability to maintain an adequately warm home, to pay their energy bills on time, as well as other questions about the condition of the dwelling ([13], [26]). In other words, subjective approaches aim at assessing basic parameters or characteristics of a household, which are considered as “socially perceived necessities” and whose absence can be taken as an indicator of energy poverty [27], [28]. Those indicators are based on the EU Survey of Income and Living Conditions (EU-SILC), which is conducted annually in all EU Member States. In fact, the three main indicators are: (i) inability to keep home adequately warm, (ii) arrears on utility bills (figure 1), and (iii) leaking roof,
damp walls, floors or foundation, or rot in window frames or floor. The results of the survey appear in the following figures (figures 2,3,4).

![Figure 2. Inability to keep home adequately warm.](image)

![Figure 3. Arrears on utility bills.](image)

![Figure 4. Conditions of the dwelling.](image)

It appears that even through the condition in their households are quite well, since the majority do not have indoor noise, mold or any other living conditions issues. Only 20% of the respondents in Xanthi and Drama are not able to pay their utility bills. Specifically, low income households that have faced an income decrease are the one that have difficulties. Moreover, the results reveal that in bigger cities energy poverty issues are increasing.

Specifically, other results show that in Miki and Edessa, the rates (62.5% and 54% respectively) of the energy adoption measures are low. That can be explained by the lack of resources and information as well as from the fact that in those two cities the average net-income is lower than 10.000€. In bigger cities, like Drama and Xanthi, the respondents declared that they preferred to change their attitude in order to reduce energy expenditures.

Almost 62% of households are consistent in paying the their energy bills on time, which certifies that the households in the studied area do not have particular financial difficulties. However, one in four households have arrears on utility bills.

This significant deviation among the results may be attributed to the fact that a large proportion of households reduce their energy consumption due to high energy costs and low incomes. Therefore, it is likely that the most vulnerable households, which have minimized their energy costs due to the financial crisis in Greece in the last decade, are not recorded as poor based on their net – income.
4. Concluding remarks
In the context of this study, a subjective method has been applied in order to evaluate energy poverty levels in four different cities in North Greece: Xanthi, Drama, Edessa and Miki. The main different, apart from the different citizen’s cultural characteristics and religious, were selected: and the religion of their citizens is their size. The first can are mainly urban and the other two rural areas. Energy poverty in the reference areas was estimated through three subjective indicators based on households’ self-assessment. All the necessary data for the estimation of the indicators mentioned above were collected through a survey, by using an appropriately designed questionnaire and involving 384 households. The results show that energy poverty appear mainly in more urban areas. Even though in all subject areas, appeared energy poor households that have significantly reduced their energy expenditures due to economic recession and the reduction of their income.
All in all, the results can be considered quite divergent results. It appears that even through the condition in their households are quite well, since the majority do not have indoor noise, mold or any other living conditions issues. But one in four households have arrears on utility bills. Moreover, energy poverty levels in respect to the inability to keep home adequately warm are higher in Miki, were the households are residing in old homes, built before 1980 (29.5%) and, which do not have insulation and have lower educational levels. A recent study showed that energy poverty correlates with low education levels [25], which is in accordance with the current survey results.
The levels of energy poverty do not show significant spatial variations, even though differences in the perception of “energy poverty” and the cultural habits of the surveyed areas. The annual household income of households does not exceed 10,000 € in 74% of households in Miki and 55% in Edessa. 60% and 54% have income from 10,000€ to 30,000€ are in Xanthi and Drama respectively. In all cities, a small percentage has an income of over € 30,000. 80% of households interviewed in all regions agreed that in the current economic conditions their salary is not sufficient to overcome them.
More than 78% of households live in a privately-owned home at Edessa and Drama, this percentage is increasing for Miki to 87%, while for Xanthi is 49%. In all areas, the population sample lives mainly in residences from 50m² to 150m². They are predominantly of low- and middle-income groups. 52% of the households in Edessa, 47% in Drama and 46% in Xanthi main use a boiler - oil burner as heating system, while in the Miki 65% of the households prefer wood-burner. The required thermal comfort conditions are met by 68% as they have chosen to heat their entire home, while the remaining percentage has chosen to heat only certain areas from its home.
Concluding, complementary studies employing other methods, or other sampling areas, could reveal new information and data that are linked to energy poverty.

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