WHO WILL BE AFFECTED BY RISING ENERGY PRICES?

MAP OF ENERGY EXPENDITURES OF POLES

Facing rising energy prices some household groups will reduce other expenditure in order to satisfy the energy consumption needs. According to statistics of Eurostat, energy prices in Poland, expressed in euros, are low, but in comparison to other goods and services - high. On the basis of the 2013 Polish Household Budget, we have analysed determinants of energy prices. We have confirmed the hypothesis that electricity spending is stronger related to household characteristics, whereas heating expenditures – to building characteristics. We have pointed out that the increase of electricity prices affect mainly the most numerous households, in particular large families. Contrary, the changes in prices of heating affects mostly residents of old, large houses, in small towns and in the country. Therefore, from the social perspective, limiting the energy inefficiency of non-insulated buildings and social education about energy saving are crucial.

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Abstract

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Keywords: energy expenditures, electricity expenditures, heating expenditures, household expenditures, energy prices, energy efficiency

JEL: D12, Q41, Q48

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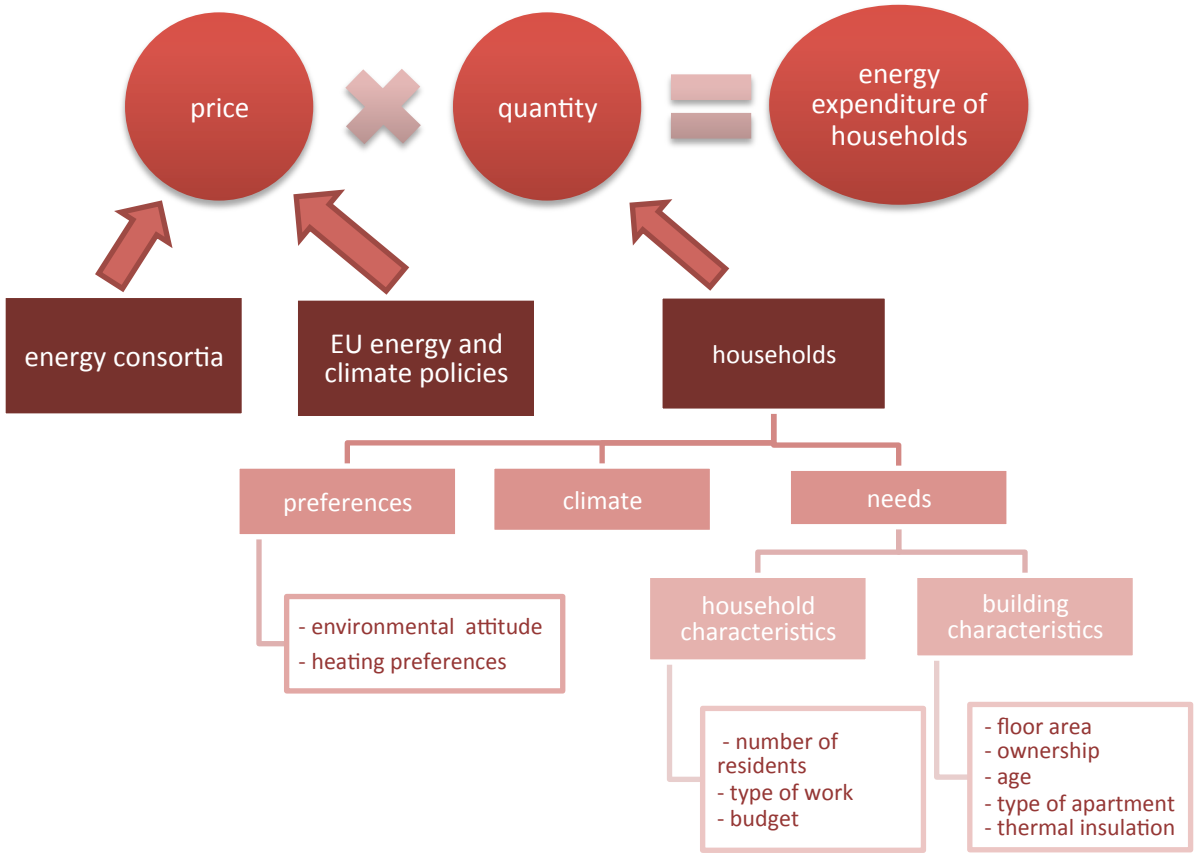
Introduction

In Poland, households spend relatively large amounts on heating, but the expenditures on electricity are average. In comparison to other European countries, the electricity in Poland is relatively cheap, but compared to the national prices turns out to be quite expensive. With respect to the expected increase of energy prices in the future, a growing number of households will not be able to satisfy their energy needs. **The aim of this study is to diagnose the scale of energy expenditure of households and to develop a map of households where the expenditure is particularly high.** The analysis will allow us to draw conclusions on the social consequences of rising energy prices, and in longer perspective, to evaluate the efficiency of the social policy instruments that are discussed in the public debate.

Figure 1. Diagram of the mechanism of energy expenditure in households in Poland.



Source: Own elaboration.

The level of energy expenditure depends on energy price and quantity of consumed energy (cf. Figure 1). In the nearest future, we may expect the energy prices to rise for a number of reasons. One involves the reduction of greenhouse gas emissions (one of the three key points of the climate and energy package, which is now being implemented). The second reason for the rise of energy prices in the long term is the depletion of non-renewable energy sources, e.g. coal, which is the key energy fuel source in Poland. Furthermore, the need to modernise Poland's energy system will result in the energy companies shifting some of the modernisation costs to the households.

Changes of energy prices will have consequences for the society. With the energy needs remaining on the same level, the rise of energy prices will negatively affect the wealth of households, in particular those where energy is a large proportion of the consumer basket. As a result, some households may be faced with the issue of the so-called energy poverty. On the other hand, for the more wealthy households, the rise of energy prices will result in the reduction of the standard of living. In extreme cases, it would force the residents to reduce the use of household appliances that increase the efficiency of home production. This will be an obstacle for the increase of the labour supply, in particular among women, which is one of the more important drives of economic growth.

The second component of energy expenditure - the quantity of energy consumed - differs across various socio-economic groups. A fundamental role for the consumption of heating is played by the energy efficiency of houses and apartments, and the climate conditions. These conditions are supplemented by the financial situation of the household, its structure (e.g. the number of children), and the preferences on the average temperature in the rooms, as well as environmental attitudes (cf. Figure 1). Of all the aforementioned elements, those most prone to state policies include: the energy efficiency of buildings, energy prices and environmental attitudes.

Reducing energy expenditure can be achieved by increasing the efficiency of energy use. The highest losses are generated by buildings without thermal insulation (ECF 2014). Negative consumer habits also contribute to energy wasting. The most frequent of those habits include leaving electronic appliances in standby mode, keeping the lights on in unused rooms, etc. Therefore, energy consumption may be reduced without affecting the standard of living through minor changes to consumer habits and investments in the improvement of energy efficiency of buildings.

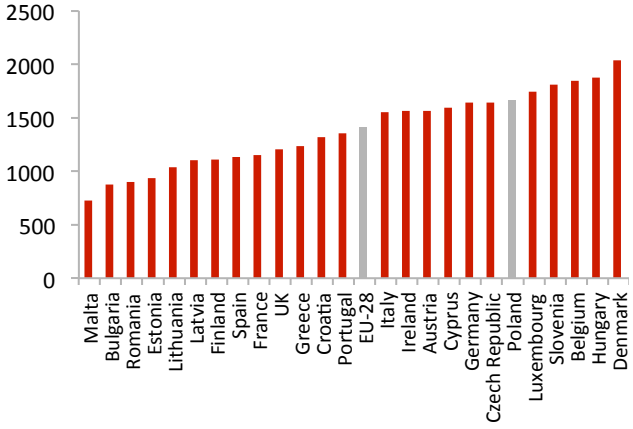
This paper is composed of four sections. The first section discusses the scale of energy expenditure in Poland as compared to other European countries. The second section includes the description of data and methodology applied in the econometric analysis. The third section contains the main analysis of the determinants of energy expenditure of households in Poland. Three main factor groups have been distinguished: socioeconomic features of households, features of residential buildings and apartments, and the features of the region. The determinants of electricity and heating expenditure are presented separately. The final section of the study summarises the obtained results and the implications thereof for the social and energy policies of Poland.

1 Context

1.1 Poland vs. EU countries

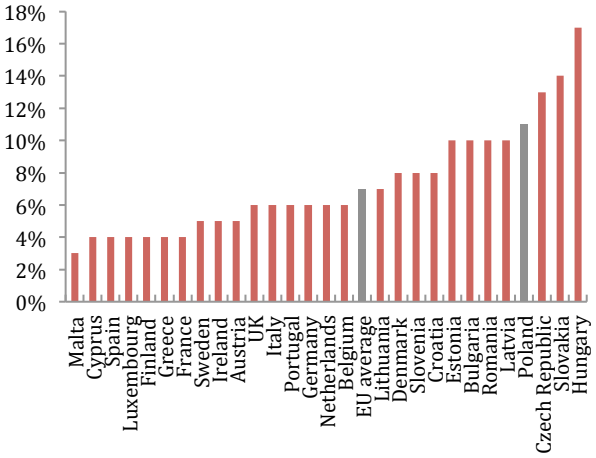
Compared to other European countries, the energy expenditures of households in Poland are high, but average in comparison to other countries of the region. In 2010, the energy expenditure amounted on average to 1,666 PPS[1] per household, as compared to the mean expenditure of 28 Member States of the EU, which amounted to 1,407 PPS (Eurostat data, cf. Chart 1). Higher energy expenditure is found in 6 EU countries, including: Slovakia (2,048 PPS), Denmark (2,037 PPS), Hungary (1,876) and Belgium (1,848 PPS). The share of energy expenditure in the total expenditure in Poland is also one of the highest in the European Union: 11% of the total expenditure, as compared to the mean for the European Union amounting to 7% (cf. Chart 2). The reason for the similar level of energy expenditure in the aforementioned countries is the fact that Central and Eastern European countries have similar climate conditions, but also domination of residential developments from the communist era, similar condition of transmission and heating infrastructure, and similar consumption patterns.

Chart 1. Energy expenditure of households in selected countries of the European Union in 2010 [PPS[2]].



Source: Own calculations based on Eurostat data.

Chart 2. The share of energy expenditure in total expenditure of households in selected countries of the European Union in 2010 [%].



Source: Own calculations based on Eurostat data.

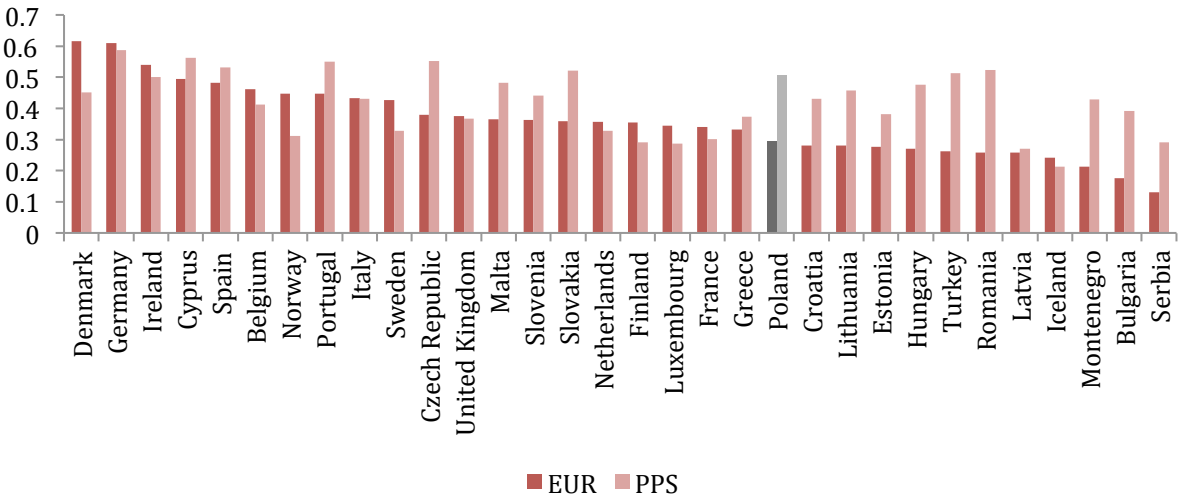
High energy expenditure may be caused by two facts: price differences and differences in the quantity of energy consumed. In Poland, electricity for households is cheaper than in most European countries (EUR 0.3 per 1 kWh in 2013). However, **the energy price level as compared to other goods and services, places Poland in the top ten most expensive Member States of the European Union** (cf. Chart 3). The nominal energy prices in Poland are over 50% lower than in Germany or Denmark, 22% lower than in the Czech Republic, but 9% higher than in Hungary and 14% than in Latvia. However, if we compare the price levels with

[1]PPS (Purchasing Power Standard) - artificial currency unit, enabling comparisons of economic indicators across different currency systems. PPS provides for different price levels between countries with the use of the purchasing power parity (PPP). Put simply, 1 PPS allows us to purchase the same amount of goods in every country in the world. In 2013, 1 PPS = PLN 2.43 = EUR 0.58 for Poland. In comparison, in 2013 in Denmark 1 PPS = EUR 1.38 and in Romania 1 PPS = EUR 0.51

[2] as above

respect to the average basket of goods, Poland turns out to be a country with relatively expensive energy, similarly to Germany, Spain, Czech Republic, Turkey, Romania, Slovakia and Hungary. If the rise of energy prices surpasses the labour efficiency increase rate in Poland, it will spell further rise of relative energy prices for households in Poland.

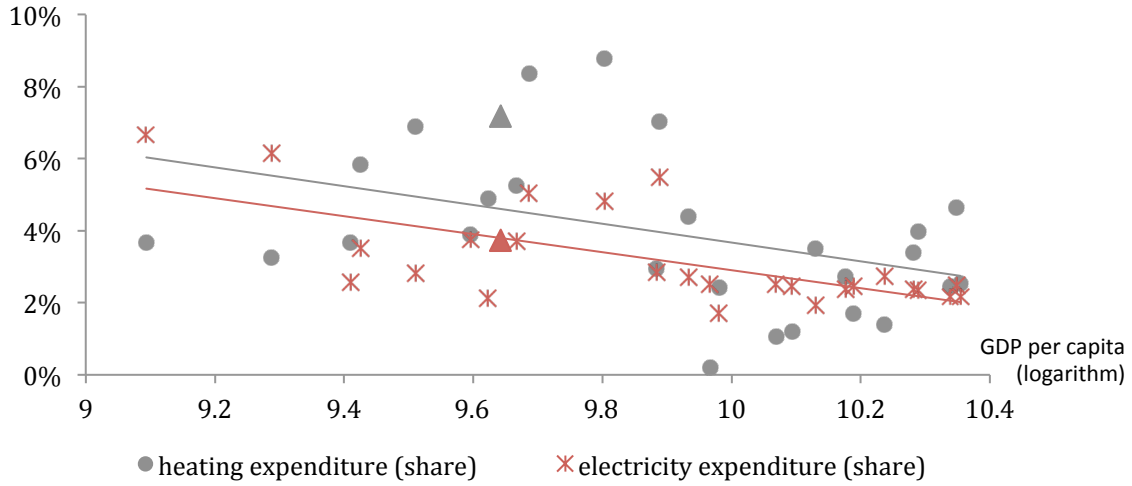
Chart 3. Electricity prices in European countries in 2013 [EUR and PPS].



Comments: The prices provided are average prices paid by a household consuming between 1,000 and 2,500 kWh annually. The price includes the price of supplying the energy, grid fee and taxes. The value expressed in PPS indicates the level of energy prices as compared to other goods in the country, and price expressed in EUR indicates the level of energy prices converted by the nominal exchange rate.
Source: Own calculations based on Eurostat data.

Electricity prices in Poland are so high compared to other goods that they limit demand more than in other countries. As a result, the share of electricity expenditure in total expenditure amounts to 3.7%, i.e. the level implicated by Poles' wealth. **The relatively high share of energy expenditure is the result of high heating expenditure** (cf. Chart 4). In Poland, households spend 7% of their income on heating, while other countries, if their income was identical to Polish, would spend 5% on average. In terms of high heating expenditure, Poland is similar to Latvia, Hungary, Czech Republic and Slovakia, and differs considerably from Lithuania, Estonia and Croatia. With the growth of the wealth of the countries, the share of electricity and heating expenditure drops at a similar rate: growth of GDP per capita by 10% results in a simultaneous reduction of the share of electricity and heating expenditure by 0.25 percentage point.

Chart 4. The share of electricity and heating expenditure in the total expenditure of households in selected European countries[3] in 2010 [%].



Comments: Triangles indicate the value for Poland and lines indicate the inclination of the correlation line separately for heating expenditure and electricity expenditure. GDP per capita is expressed in PPS and as logarithms. Heating expenditure includes the expenditure for the following COICOP categories: CP0452-CP0455.
Source: Own calculations based on data from Eurostat.

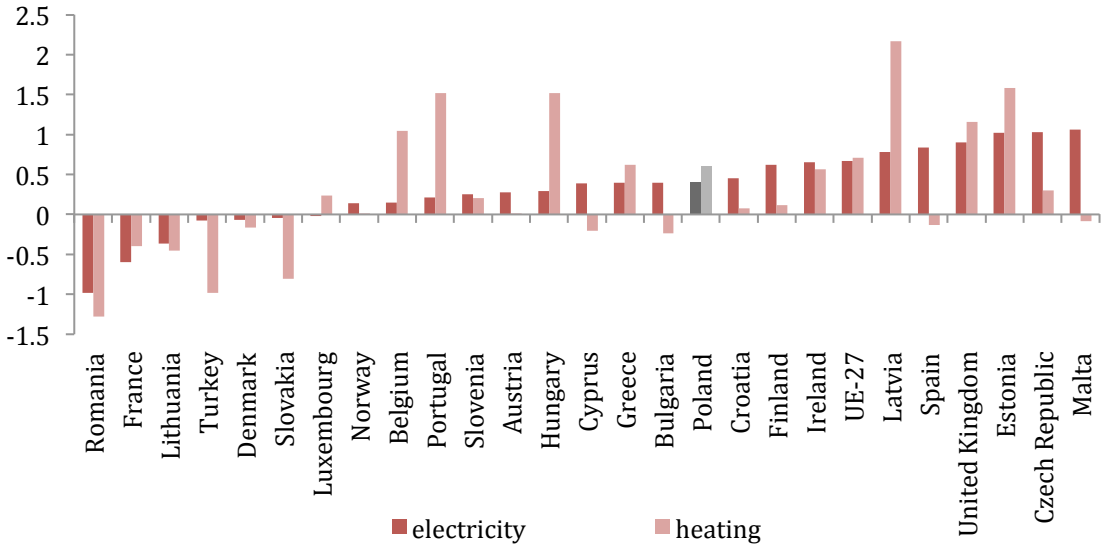
To sum up, **Poland is characterised by high share of energy expenditure in the total household expenditure due to low income level and high heating expenditure.** In these terms, Poland does not significantly differ from other, similar countries in the region. It is heating, rather than electricity, that shows potential for energy efficiency improvement in Poland.

1.2 Dynamics of Energy Expenditure

Contrary to the long-term downward trend of the share of energy expenditure in the total expenditure, with the increase of income between 2005 and 2010, in the majority of European countries both the electricity expenditure and heating expenditure have increased by 0.7 percentage points. The change has been partially caused by the drop of income resulting from the financial crisis. In Poland, the increase in the share of expenditure related to both electricity and heating (by 0.4 and 0.6 percentage points, respectively) (cf. Chart 5) and was lower than in the Czech Republic, but higher than in Slovakia, where the shares have decreased. Therefore, the data discussed herein do not confirm the conclusion formulated by Dziakowicz-Grudzień (2014), who stated that the increase of energy expenditure of households in Poland is related to increased electricity consumption, and that the share of expenditure spent on heating (solid and liquid fuel) in the structure of energy expenditure is reduced over time. As the result, they indicate, on the one hand, the larger numbers of electric appliances in households, and on the other, the use of energy-saving heating technologies, e.g. simultaneous heating of water and rooms.

[3] Data for: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Latvia, Montenegro, Former Yugoslav Republic of Macedonia, Malta, Poland, Portugal, Romania, Slovenia, Slovakia, Turkey, United Kingdom.

Chart 5. Change of the share of electricity and heating expenditure (in percentage points) in total expenditure in the years 2005-2010 in European countries [%].



Comments: The heating expenditure includes the expenditure for the following COICOP categories: CP0452-CP0455.
Source: Own calculations based on Eurostat data.

The energy expenditure in Poland exhibits an upwards tendency, i.a. due to rising prices. In 2006, the average monthly expenditure amounted to PLN 86 per capita, while in 2012, it was PLN 127. Therefore, the nominal energy expenditure between 2006 and 2012 increased by 48%. Over the same period, the nominal GDP growth was 52% and the rise of energy carrier prices was 60%.[4] Also, the share of energy expenditure in the total expenditure of households is slightly rising: from 11.6% in 2006 to 12.3% in 2012 (Dziakowicz-Grudzień 2014).

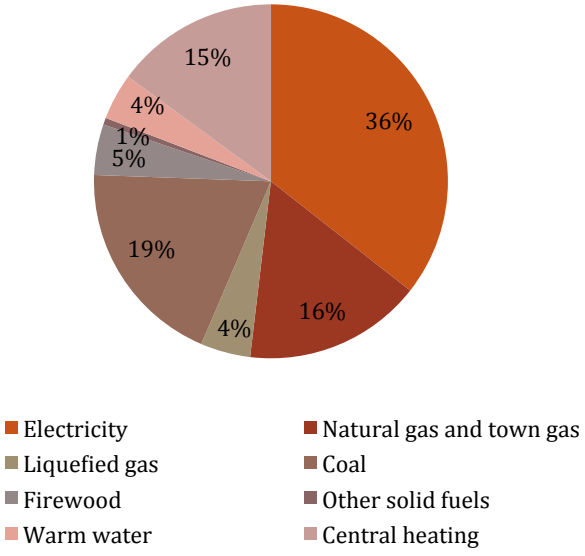
The increase of the energy expenditure is followed by the growth of the number of households that save energy. The surveys of environmental attitudes of Poles indicate that the number of people saving energy is growing. In 2012, energy saving was declared by 94% of citizens, compared to 89% the year before. The main declared methods of saving energy include: turning off the light in unused rooms (78%), using energy-saving lightbulbs (53%), sealing windows (48%), and using energy-saving household appliances (38%). Also frequently declared were: turning down the heaters (30%), not using the standby mode in household appliances and electronic devices (25%), and thermal insulation of buildings (16%). However, the majority of Poles (59%) are not ready to agree to higher expenditure to implement environmentally friendly solutions. Half of the Polish citizens would also not agree to spend more on clean energy due to its environmental values (TNS 2012).

[4] Data from the Central Statistical Office of Poland (GUS).

1.3 Structure of Energy Expenditure

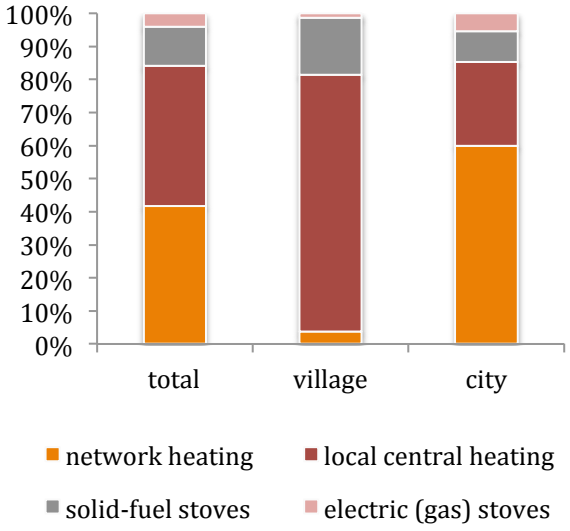
The structure of energy expenditure is a consequence of the method of heating the apartment or house (cf. Chart 6). **In Poland, the dominating system is the local central heating (42% of households)**, i.e. heating the entire house or several apartments with the use of a boiler installed in the basement of the building or in the utility room (cf. Chart 7). The stoves operate either on liquid fuels (natural gas, liquefied gas, heating oil) or solid fuels (coal, coke, wood, etc.) (GUS 2013). This heating method is prevalent in rural areas (78% of households). The second group consists of households using heat from the network heating system (41.7% of households). These include mainly residents of cities (60% of households). The third method of heating includes stoves fired by coal, biomass or other solid fuels used to heat one room - 11.8% of households (in rural areas: 17.1%). A few households are heated with electric or gas stoves.

Chart 6. Structure of expenditure on energy carriers of households in Poland in 2013 [%].



Source: Own calculations based on data from BBGD 2013.

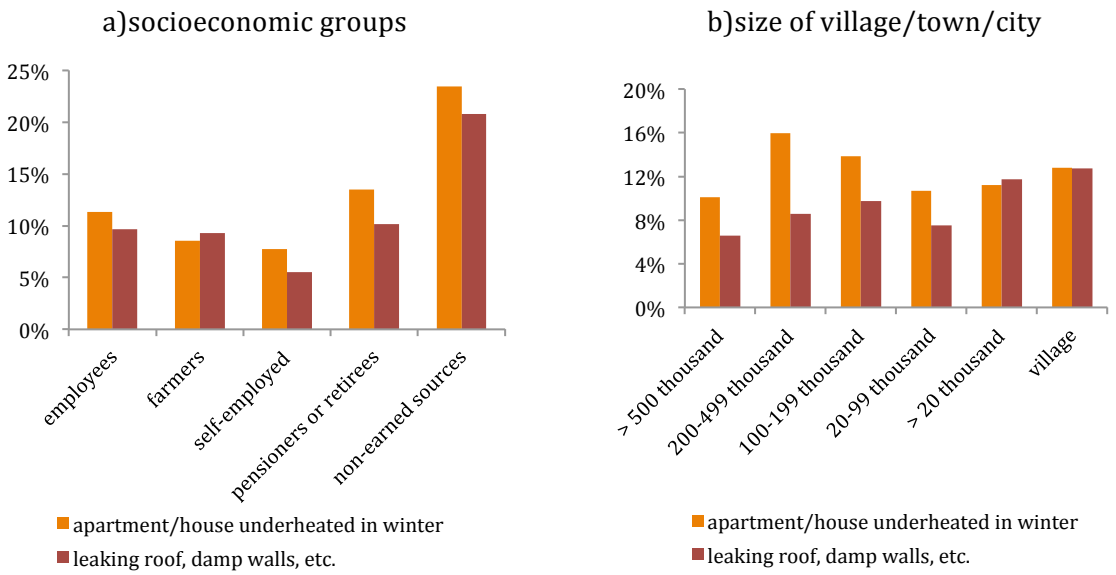
Chart 7. Methods of heating rooms in households in Poland in 2013, in urban and rural areas [%].

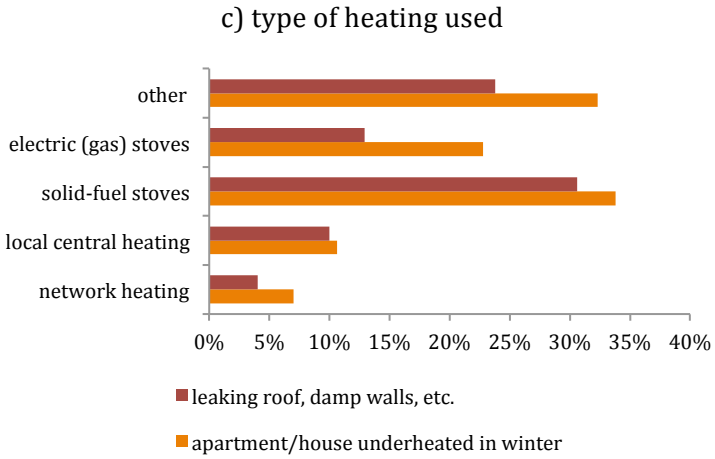


Source: Own calculations based on data from BBGD 2013.

Some households in Poland are forced to reduce their energy consumption below their needs. The households in underheated apartments or in properly heated apartments, but saving on other goods and services (e.g. food, clothes or healthcare) are defined as suffering from *energy poverty* (cf. Węglarz et al. 2014). In 2013, 18% of households in Poland resided in apartments that were underheated or had damp walls. This issue concerns mainly residents who make their living on non-earned sources of income, e.g. unemployment benefits (23% - underheated apartments; 21% - damp apartments), inhabitants of rural areas (13% - damp houses), and residents heating their apartments with solid-fuel stoves (34% - underheated apartment; 31% - damp apartment) (cf. Chart 8).

Chart 8. Percentage of households affected by energy poverty in Poland in 2013 according to subjective assessment, and:





* In point c. the sample refers to households with one dwelling/house and above the 1th percentile of disposable income (254zł).
** The category of "leaking roof" also refers to damp walls and floors, and rotting windows.
Source: Own calculations based on data from BBGD 2013.

2 Data and Methodology

2.1 Data

The data used to conduct this econometric study comes from the 2013 Polish Household Budget Survey (BBGD). We draw on the BBGD Survey as it provides detailed data on monthly household expenditure and revenue, household socio-economic characteristics and physical features of apartments and household property. Our analysis, for which we used a sample of 37,181 observations, rejected households with more than one apartment (429 observations – 1% of the sample). Their energy spending levels were higher than that of households living in one apartment by 41% on average. Moreover, it is not possible to conduct a thorough analysis in the absence of information on the additional apartments. The authors have also excluded 1% of households with lowest disposable income, i.e. monthly income of less than PLN 254 (410 observations). Half of these households report zero disposable income and energy expenditure of PLN 211. Thus, we consider these observations to be an erroneous outcome of income irregularity which affects e.g. farmers. In conclusion, the study was carried out for a sample of 36,342 households.[5]

The primary objective of this study was to analyse household energy spending. For our purposes, only data on monthly household expenditure is available. This might exert negative influence on the results, as energy spending tends to vary depending on season. Energy expenditure covers such items as electricity, natural gas and other liquid fuels, solid fuels such as coal and firewood, hot water supply and central heating. Use of transportation fuels has been excluded from the analysis. The above-listed energy sources can be used for the following purposes:

- heating: of rooms, water and meals,
- lighting,
- air conditioning,
- operation of household appliances and electronic devices,
- performance of work (people working from home and farmers).

The aim of this study is to estimate the determinants of household energy consumption, therefore rural household energy spending levels, used for both consumption and production, might disrupt analysis results (GUS 2013). However, after conducting a separate analysis of agricultural households and an analysis where such households were excluded, no significant differences between the results were revealed. Consequently, the results presented in this article include all households.

[5] The Household Budget Survey (BBDG) is carried out for a random sample of households, which means that results measured from this sample are also true for the entire population. Thanks to the application of analytic weights, the results presented herein are true for 13.28 million Polish households.

2.2 Methodology

In order to estimate the determinants of household energy spending, a linear regression was carried out where energy expenditure is dependent on three groups of drivers of energy spending:

$$E = \alpha + S\beta + M\gamma + K\delta + \varepsilon$$

where:

E - vector of monthly household energy spending (logarithm),
S - matrix of household socio-economic characteristics,
M - matrix of physical features of the apartment,
K - matrix of climate-related and regional features,
α, β, δ, - estimated parameter vectors,
ε – vector of random factor implementation.

Socio-economic characteristics indicate households' needs (e.g. arising from number of household members or employment type) and their energy preferences (e.g. room temperature). Physical features of the apartment, such as building age and type or floor area, might impact heating needs. Apartment location may cause heating expenditure to vary across regions and is indirectly dependent on households. Other factors, discussed in greater detail in Chapter 3.3, might also have an impact on energy spending levels (cf. Figure 1). The selected factors are compliant with those included in similar studies conducted in states other than Poland (Eakins, 2013). The issue of seasonality is ameliorated by including monthly dummy variables in our model. The Ordinary Least Squares method (OLS) is used to estimate the presented correlation.[6] This methodology allows for estimating mutual correlations between several variables observed at the same time. Overall energy spending and energy expenditure were analysed, broken down into electricity[7] and room heating (calculated as overall energy decreased by electricity expenditure[8]). In this study, independent variables are formed by such characteristics as physical features of apartments and number of household members, therefore logarithms of energy expenditure are the dependent variable.

We exclude households which report a zero figure for their energy spending. We assume this is a consequence of the monthly observation frequency, as energy payments often cover longer periods. Such households correspond to 5% of the sample in terms of total energy spending, 24% as concerns electricity expenditure, and 16% in the case of heating spending. Exclusion of households with zero energy spending from the estimate is tantamount to the assumption that the random factor does not have any effect on the absence of energy expenditure (Rubin, 1987).

[6] Discrete models, mixed models (mixed discrete-continuous variables, e.g. energy spending and heating type) and a system of demand equations (equations representing demand for various goods, including electricity) (Eakins, 2013) are examples of other models applied in subject literature.
[7] We exclude households which named electric (gas) stoves as their main sources of heating. Such households cater for approx. 4% of households.
[8] This is a rough estimate, as it does not include expenditure on use of electric heaters. This means that approx. 4% of households are excluded.

3 Determinants of Polish Household Energy Spending

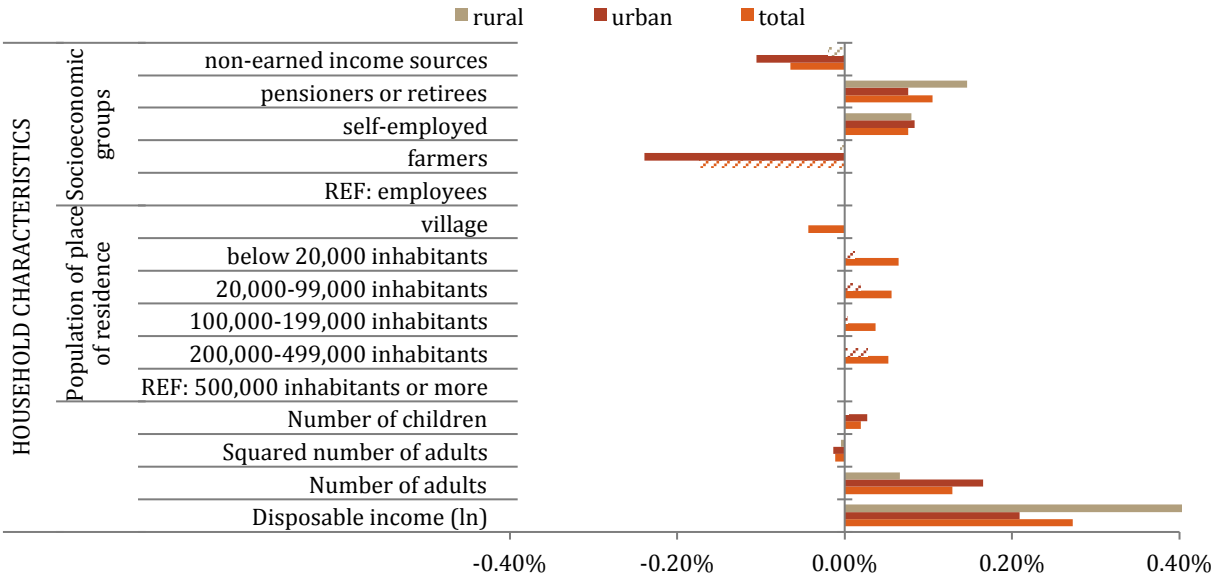
3.1 Significance of Socioeconomic Characteristics

Selected results of estimations are broken down into three separate categories: socioeconomic characteristics, physical features of apartments and other factors. The complete linear regression results have been presented in the appendix.

1.1.1 Income

Income increase is connected with limited growth of demand for energy. Energy is a necessity good (cf. Varian 2014). An increase in income by 1% translates into a rise in energy spending by 0.27% (cf. Chart 9). The scale of this correlation is compliant with the results obtained by other authors (among others for Sweden: 0.01% (Hårsman and Wahlström 2014) and for Great Britain: 0.04% (Meier and Rehdanz 2010)). This can be accounted for by the microeconomic theory of consumer selection (cf. Varian 2014). Households with larger budgets are capable of increasing their consumption of, for example, electricity. It may at first seem counterintuitive that electricity is more of a necessity good than heat, yet the effect of income fluctuations is stronger for heating expenditure than for electricity spending levels (0.21% vs. 0.14%, cf. Chart 10).[9]

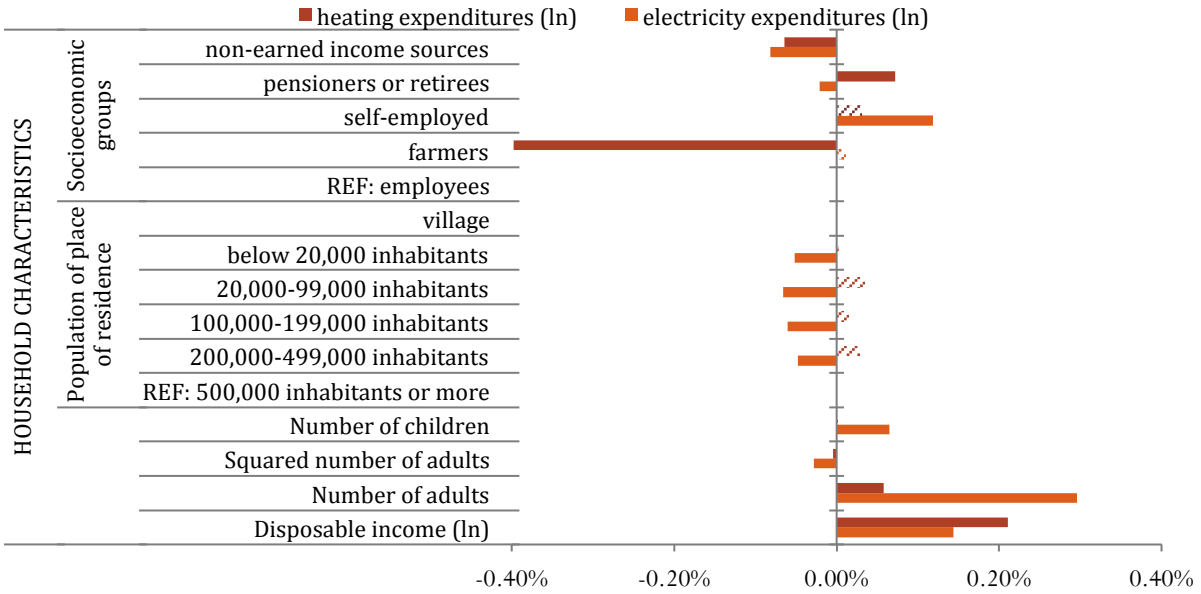
Chart 9. Influence of household characteristics on energy expenditure in Poland in 2013, broken down into rural and urban areas.



* This chart presents parameter estimations calculated in linear regression. The hatched bars represent statistically insignificant variables at the 5% significance level.
** Rural and urban area models do not include households with expenditure from the 99th income percentile (more than PLN 13,506.67 – 410 observations).
*** The complete results of linear regressions have been presented in the appendix.
Source: Own calculations based on 2013 BBGD data.

[9] Analyses of electricity and heating spending levels were performed for cities.

Chart 10. Influence of household characteristics on electricity and heating expenditure in Poland in 2013.



* This chart presents parameter estimations calculated in linear regression. The hatched bars represent statistically insignificant variables at the 5% significance level.
** Analysis limited to urban population.
*** The complete linear regression results have been presented in the appendix.
Source: Own calculations based on 2013 BBGD data.

3.1.1 Household Size

Increases in the number of household members is connected with increase in energy spending. The influence of the number of children under 14 and the number of "adults" (over 14) was analysed separately.[10] A new household member translates into an increase in electricity expenditure by 29% and heating spending by 6%. This difference results from the use of every-day electronic devices: each adult incurs costs of using a mobile phone, computer, etc. This hypothesis is also justified by the fact that the impact of the number of adults on energy expenditure is different in rural and urban areas. Each new adult member of an urban household, which consumes more electricity than a rural household, triggers an increase in energy expenditure by 16%, whilst in rural areas this increase amounts to 7% (cf. Chart 9). Although each new family member causes electricity expenditure to increase, a downward trend is observed for each such increase (each successive increase is lower by 1%). This trend is driven by the economies of scale – such appliances as washing machines, refrigerators and television sets can be simultaneously used by more than one person (cf. Varian 2014). Studies performed in countries other than Poland yielded similar outcomes (e.g. Chambwera and Folmer 2007; Filippini and Pachauri 2004). **The number of children is also related to increases in electricity expenditure, yet to a much lesser extent than the number of adults (6% vs. 29%).** The number of children does not have any effect on heating expenditure. Therefore, the hypothesis that heating is increased so as to ensure levels of warmth comfortable for children remains unfounded. Surveys carried out for countries other than Poland confirmed that the effects of this household feature are ambiguous (e.g. in Great Britain

[10] The age of 14 was adopted as the boundary between childhood and adulthood due to specific features of the database. A similar division was applied i.a. when determining OECD equivalence scales (compare: Ciecieląg 2003).

it caused energy spending to increase – Meier and Rehdanz 2010, in Germany it led to a decrease in energy expenditure – Rehdanz 2007, and no effect was noted in Norway – Vaage 2000).

3.1.2 Household Location

In general, urban households spend more on energy than rural households. Interestingly, energy spending of households located in towns with populations smaller than 20,000 seems to be higher by almost 7% than energy expenditure of households living in agglomerations with populations of more than 500,000 (cf. Chart 9). Highest electricity spending levels are observed in urban agglomerations and heating expenditure is not driven by the population size of a household's location (cf. Chart 10).

3.1.3 Socioeconomic Group

Highest overall energy expenditure is incurred by two groups: pensioners or retirees and the self-employed. Energy spending levels of the former group exceed those of employees by 10%, nominally, whilst energy expenditure incurred by the latter group is higher than that of employees by 7%. Our analysis of heating[11] and electricity spending levels provided similar results. It follows from Chart 10 that high energy spending of the former group was driven by high heating expenditures (higher than employees' expenditure by 7%). This is caused by the fact that the elderly maintain higher levels of warmth in their apartments, not by the fact that this group resides in buildings with ineffective heating systems.[12] The energy expenditure structure of the self-employed is dominated by electricity expenditure (higher than in the case of employees by 11%). This might mean that electricity is used for purposes of work performance. Lowest total energy expenditure is incurred by households living on non-earned sources, e.g. unemployment benefits (less than employees' expenditure by 7%).

When analysing the impact of both socioeconomic groups and household location, it ought to be borne in mind that low energy spending levels might indicate that apartments are inadequately heated, i.e. are affected by so-called energy poverty. This interpretation is confirmed by the fact that **as many as 28% out of 10% of the lowest-income households report that their apartment is inadequately heated in winter periods, whilst only 10% out of the 10% of the highest-income households declare such difficulties.** Similarly, Kurowski (2014) argues that households with lowest energy spending levels, i.e. households living on non-earned income sources, households of farmers and rural residents, are most exposed to energy poverty. Similar conclusions can be drawn from analysing 2013 data: the group of households living on non-earned income sources is characterised by the highest share of households reporting such inconveniences as leaking roofs, damp walls and apartments which remain cold throughout the winter (21% and 23% of households, respectively, cf. Chart 8a). Reports of leaking roofs and damp walls are also most frequently submitted by residents of rural areas (13% of households, as compared to an average of 9% in urban areas – cf. Chart 8b).

***

Physical features of households have greater impact on energy spending than on heating expenditure. It was found that a greater portion of features analysed is statistically significant

[11] Farmers residing in urban areas incur lowest heating expenditure. However, owing to the small size of this group (0.34% of urban households), it should be considered to form an exception.

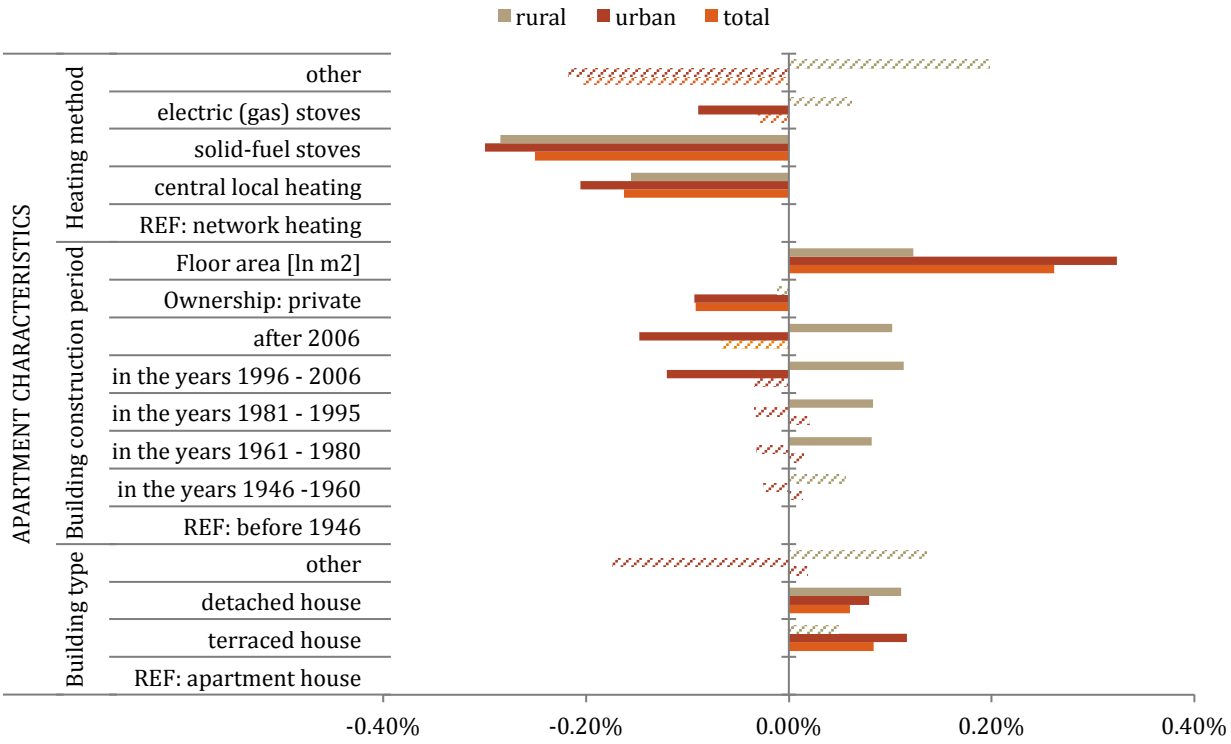
[12] The structure of physical properties of pensioners or retirees' apartments and apartments of other social groups is comparable.

in relation to energy spending than in connection with heating expenditure (respectively: 11 out of 12 analysed features and 5 out of 12 analysed features). This indirectly corroborates the hypothesis that electricity use is driven by consumption patterns and preferences, whilst heating expenditure is to a larger extent dependent on the physical features of buildings.

3.2 Differentiation of Households

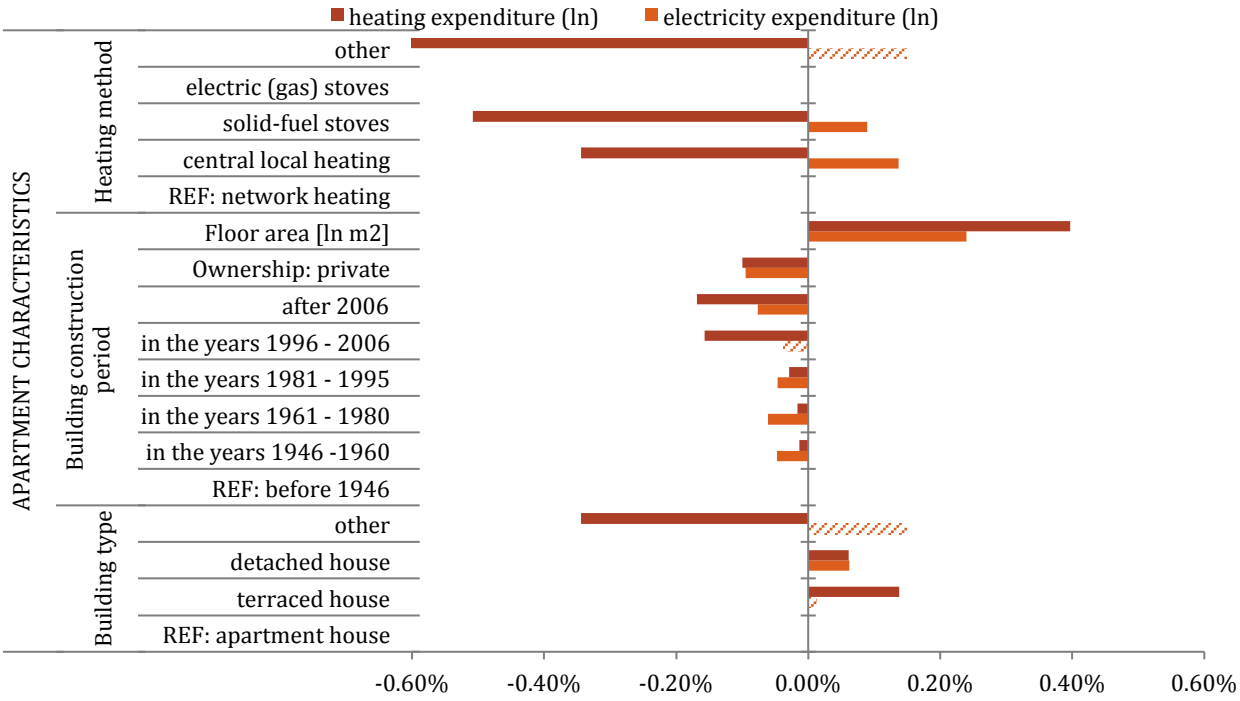
The energy efficiency of buildings and electrical devices directly affects energy expenditure, in particular heating expenditure. As the BBGD Survey does not provide data on energy efficiency classes of household appliances and electrical devices, data on physical features of buildings was used.

Chart 11. Influence of physical features of apartments on energy expenditure in Poland in 2013, broken down into rural and urban areas.



* This chart presents parameter estimations calculated in linear regression. The hatched bars represent statistically insignificant variables at the 5% significance level.
** Rural and urban area models do not include households with expenditure from the 99th income percentile (more than PLN 13,506 – 410 observations).
*** Complete linear regression results have been presented in the appendix.
Source: Own calculations based on 2013 BBGD data.

Chart 12. Influence of physical features of apartments on electricity and heating expenditure in Poland in 2013.



* This chart presents parameter estimations calculated in linear regression. The hatched bars represent statistically insignificant variables at the 5% significance level.
** Analysis limited to urban population.
*** Complete linear regression results have been presented in the appendix.
Source: Own calculations based on 2013 BBGD data.

3.2.1 Physical Features of Buildings

Floor area is the highest-impact determinant of energy expenditure. This becomes particularly obvious when analysing heating expenditure: a 10% increase in floor area translates into a 4% increase in heating spending. A notable difference between rural and urban areas is also revealed: a 10% increase in floor area translates into an increase in heating spending by 3.2% and 1.2%, respectively. Floor area is classed as a statistically significant driver of energy spending in all research carried out in this field of study (Eakins 2013).

Highest energy expenditure is incurred by households living in terraced houses, semi-detached houses and detached houses (as compared to blocks of flats, their energy spending is higher by 8% and 6%, respectively, cf. Chart 11). Differences between terraced houses and semi-detached houses are revealed when analysing heating expenditure, which is higher than that incurred by households living in blocks of flats by 14% and 6%, respectively (cf. Chart 12). This is observed despite the fact that terraced houses have higher energy efficiency, which is catered for by smaller external wall surface and lower heat loss due to transmission through walls. However, a portion of households living in detached houses (especially in rural areas) cannot appease their heating needs owing to their financial standing. Other reason could be preferring lower temperatures in the dwelling. Lowest energy expenditure is incurred by households living in blocks of flats and other apartment buildings. Research on differences in spending by building type conducted in states other than Poland generate similar results (cf. Vaage 2000; Meier and Rehdanz 2010).

BBGD data do not allow for direct observations of the energy efficiency of buildings. The most similar available data allowing for making estimates of this value is the **building age**. **Households living in buildings constructed after 2006 incur much lower energy expenditure.** Overall energy spending levels are lower by 7%, and heating expenditure is lower by as much as 17% (cf. Chart 12). More often than not, new buildings are more energy efficient than old ones. In rural areas, overall energy expenditure of households living in older buildings is lower than that of households living in newer buildings. To provide an example: households residing in buildings constructed in the years 1961-1980 spend 8% more on energy than households living in older apartments, and residents of houses constructed in or after 2006 – 10% more). This might indicate inadequate heating of rooms in older buildings. Apart from building age, property ownership also impacts energy spending. **Households living in privately-owned homes spend on electricity and heating 10% less than those of households residing in public housing, commune-owned properties, etc.** Rehdanz (2007) also points to higher energy spending in older buildings.

3.2.2 Heating Method

The analysis of the impact of the heating method on expenditure does not allow for drawing unequivocal conclusions. Highest spending, in terms of both general energy and heating, is incurred by households using the central heating system, i.e. most often those living in blocks of flats (correlation of 0.69). Households using local heating stoves spend 16% less on energy, and solid-fuel stoves – as much as 25% less in comparison to households using the central heating system (cf. Chart 11). To a large extent, this is caused by inadequate heating of rooms: every third household using solid-fuel stoves admits that its apartment is not sufficiently warm in winter (34%, cf. Chart 8c). This result is confirmed by a high share of solid-fuel stove users who report leaking roofs or damp walls in their apartments (31%).

***

When comparing the impact of physical features of buildings and household characteristics on energy and heating spending, we can confirm the result obtained for Sweden (Hårsman and Wahlström, 2014). **Household characteristics have greater impact on energy spending, and physical properties of buildings exert greater influence on heating expenditure.** It follows from simple arithmetic calculations that the average impact of building physical features on heating spending amounts to 28%, and their effect on electricity expenditure equals 10%. Moreover, the number of physical features which are statistically significant is higher in the case of heating expenditure (77% as compared to 9% in the case of electricity spending).

3.3 Other Factors

3.3.1 Regional Location

Some surveys, especially those on heating expenditure, also include climate-related factors (e.g. Vaage, 2000). They are most frequently combined with regional factors, which makes it hard to differentiate between climate-related characteristics (average temperatures, etc.) and consumer preferences fuelled by regional characteristics.

The BBGD Survey provides only general data at region (province) level. **Regional location proved statistically insignificant in half of the analysed cases**. The following regions incur higher heating expenditure than the Mazowieckie Region: Opolskie, Świętokrzyskie, Podkarpackie, Warmińsko-Mazurskie and Lubuskie. Lower spending levels are observed in

Lubelskie and Pomorskie Regions. The largest difference is noted between the Małopolskie and Lubelskie Region: 25% (cf. Appendix). Whilst higher expenditure in the Warmińsko-Mazurskie Region might be triggered by lowest average annual temperatures across Poland, interpreting the results obtained for other regions poses serious difficulties.

3.3.2 Dropped Factors

The above determinants are not an exhaustive list of factors impacting energy spending. For example, surveys of energy expenditure incurred in third-world countries take into account information about the head of the family, such as education, age and gender (e.g. survey for Nigeria: Ogwumike et al. 2014). In countries where detailed databases of physical features of buildings are available, information on recent window replacements, window type, etc. is also used (e.g. survey for Norway: Hårsman and Wahlström 2014). When more detailed data are available, surveys also make use of information on the proportion of warm and cold days in a year (e.g. for Norway: Hårsman and Wahlström 2014). Such research describes household energy expenditure patterns in greater detail, however, absence thereof does not undermine analysis correctness.

In this analysis, energy prices were dropped, as these are not observed at household level. As a result, this analysis does not provide an answer to the very significant social question of whether an increase in energy prices would cause a decrease in energy use or rather result in limited consumption of other goods. Answering this question requires broader-scope data and different methods.[13]

[13] The Institute for Structural Research will conduct research on this issue in the second half of 2015.

4 Discussion of Results and Conclusions

Energy expenditure **grows at a slower pace than income**. Therefore, greater wealth, both individual and aggregated, leads to an increase in demand for energy and a decrease in the share of energy spending in income. Despite this long-term trend which was observed in the years 2005-2010, **the share of energy spending in overall expenditure increased in both Europe and Poland.** This is a warning signal that long-term trends might be reversed by an economic downturn and significant increases in energy carrier prices.

Greater chances of **reducing energy expenditure** has been identified in Poland in case of heating rather than electricity. **Relative electricity prices in Poland remain high** as compared to other EU Member States, which should induce Poles to save energy. However, the price mechanism is not strong enough to persuade households to increase the energy efficiency of buildings. Thus, applying thermal insulation and selection of more energy-efficient construction technologies requires that dedicated instruments be launched and applied. The design of these instruments must ensure that they can also be used by poor households which fail to satisfy even their basic needs despite a high share of energy spending in overall expenditure.

Household energy spending varies across both physical features of buildings and household characteristics. Electricity spending is driven by factors other than those impacting heating expenditure. **Electricity spending is to a larger extent determined by household characteristics than by physical features of apartments**. The following characteristics are of paramount importance: number of household members and source of income. **Heating spending is to a larger extent determined by physical features of buildings than by household characteristics**, in particular: floor area and heating method.

In Poland, highest energy expenditure is incurred by: wealthy households, households of the self-employed, households living in large apartments and households using the central heating system. High energy spending of this group is probably driven by high levels of wealth. Another group which incurs highest energy expenditure is constituted by households: **with the highest number of members, households of pensioners or retirees, households living in towns with a population under 20,000, households living in public housing, old buildings, terraced houses, semi-detached houses and detached houses.** An increase in energy prices will affect mainly these households. In extreme cases, it might force them into income poverty. Low energy spending levels observed in some household groups, e.g. farmers, are the result of **failure to satisfy energy needs**.

Heating expenditure is to a large extent dependent on physical features of apartments. Hence, **applying thermal insulation in buildings** (insulating homes, window and roof replacement, etc.) and use of **more effective heating methods** (e.g. bifunctional boilers) might contribute to a reduction of heating expenditure. It is not possible to reduce electricity expenditure without taking actions other than those undertaken to decrease thermal energy spending: it is necessary to **change consumer mentality**, i.e. improve the situation in the labour market and encourage consumers to save energy. The following are exemplary actions taken in this area: environmental education at schools, social campaigns encouraging residents to save energy, etc. On a larger scale, a drop in "unnecessary" energy expenditure might also be brought about by improvements in the social status of households.

Some of the proposed solutions connected with establishing new social attitudes are already being implemented in Poland, however, they require further development. Such actions fall within the remit of such state authorities as: the Ministry of Infrastructure and Development, the Ministry of the Environment, the Ministry of Labour and Social Policy, the Ministry of National Education and the Ministry of Economy.

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Appendices

Table 1. Results of linear regression on energy expenditure, broken down into urban and rural areas.

		Subpopulations:		
		total	*urban*	*rural*
HOUSEHOLD CHARACTERISTICS				
Disposable income (ln)		0.272*	0.209*	0.413*
Number of adults[1]		0.128*	0.165*	0.066*
Squared number of adults[1]		-0.011*	-0.014*	-0.004
Number of children[2]		0.019*	0.027*	0.005
Population of place of residence	REF: 500,000 inhabitants or more			
	200,000-499,000 inhabitants	0.052*	0.028	-
	100,000-199,000 inhabitants	0.037*	0.003	-
	20,000-99,000 inhabitants	0.056*	0.019	-
	below 20,000 inhabitants	0.064*	0.012	-
	village	-0.043*	-	-
Socioeconomic groups	REF: employees			
	farmers	-0.173*	-0.239	-0.005
	self-employed	0.076*	0.083*	0.079*
	pensioners or retirees	0.105*	0.076*	0.146*
	non-earned income sources	-0.065*	-0.105*	-0.020
PHYSICAL FEATURES OF APARTMENT				
Ownership: private		-0.092*	-0.093*	-0.011
Floor area [ln m^2]		0.262*	0.323*	0.123*
Building type	REF: apartment house			
	terraced house	0.084*	0.117*	0.049
	detached house	0.060*	0.079*	0.111*
	other	0.018	-0.174	0.135
Building construction period	REF: before 1946			
	in the years 1946-1960	0.014	-0.025	0.056
	in the years 1961-1980	0.015	-0.032	0.082*
	in the years 1981-1995	0.020	-0.034	0.083*
	in the years 1996-2006	-0.033	-0.120*	0.113*
	after 2006	-0.066*	-0.147*	0.102*
Heating method	REF: central heating system			
	local central heating system	-0.163*	-0.205*	-0.156*
	heating stoves	-0.250*	-0.300*	-0.285*
	electric (gas) stoves	-0.030	-0.089*	0.062
	other	-0.203	-0.218	0.198

REGIONAL/CLIMATE-RELATED CHARACTERISTICS				
Region	REF: Mazowieckie			
	Dolnośląskie	-0.022	-0.023	-0.143*
	Kujawsko-Pomorskie	0.025	0.026	0.224*
	Lubelskie	-0.169*	-0.145*	0.046
	Lubuskie	0.047	0.102*	-0.180*
	Łódzkie	0.006	-0.010	0.187*
	Małopolskie	0.080*	0.060*	-0.010
	Opolskie	-0.064*	-0.013	-0.211*
	Podkarpackie	0.047*	0.013	0.164*
	Podlaskie	-0.097*	-0.008	-0.475*
	Pomorskie	-0.072*	-0.058*	0.056
	Śląskie	0.052*	0.031	0.056
	Świętokrzyskie	-0.005	0.059	0.142*
	Warmińsko-Mazurskie	0.041	0.094*	-0.208*
	Wielkopolskie	0.022	-0.013	0.253*
	Zachodniopomorskie	0.052*	0.037	0.087
Month of survey performance	REF: January			
	February	-0.005	0.021	-0.040
	March	-0.024	-0.009	-0.080*
	April	-0.100*	-0.045*	-0.211*
	May	-0.154*	-0.099*	-0.276*
	June	-0.190*	-0.150*	-0.319*
	July	-0.164*	-0.138*	-0.241*
	August	-0.115*	-0.128*	-0.059
	September	-0.058*	-0.086*	0.020
	October	-0.044*	-0.072*	-0.014
	November	-0.056*	-0.063*	-0.043
	December	-0.081*	-0.089*	-0.071
Constant		2.282	2.562	1.692
R^2		14%	18%	19%
Number of observations		34,545	20,143	12,548
Ovtest (p-value)		0.642	0.202	0.194

[1] Members of household >14 years of age.

[2] Members of household < 14 years of age.

Comment: Significance at five-percent level is indicated by *.

Source: Own calculations based on 2013 BBGD data.

Table 2. Results of linear regression on energy expenditure, broken down into energy types.

		electricity expenditure (ln)	heating expenditure (ln)
		urban	*urban*
HOUSEHOLD CHARACTERISTICS			
Disposable income (ln)		0.144*	0.210*
Number of adults[1]		0.296*	0.058*
Squared number of adults[1]		-0.028*	-0.004
Number of children[2]		0.065*	0.001
Population of place of residence	REF: 500,000 inhabitants or more		
	200,000-499,000 inhabitants	-0.048*	0.028
	100,000-199,000 inhabitants	-0.060*	0.015
	20,000-99,000 inhabitants	-0.065*	0.034
	below 20,000 inhabitants	-0.051*	0.003
	village	-	-
Socioeconomic groups	REF: employees		
	farmers	0.011	-0.398*
	self-employed	0.119*	0.030
	pensioners or retirees	-0.021*	0.072*
	non-earned income sources	-0.082*	-0.065*
PHYSICAL FEATURES OF APARTMENT			
Ownership: private		-0.095*	-0.100*
Floor area [ln m^2]		0.239*	0.396*
Building type	REF: apartment house		
	terraced house	0.013	0.138*
	detached house	0.062*	0.061*
	other	0.150	-0.344*
Building construction period	REF: before 1946		
	in the years 1946-1960	-0.047*	-0.013
	in the years 1961-1980	-0.061*	-0.017
	in the years 1981-1995	-0.046*	-0.029
	in the years 1996-2006	-0.037	-0.157*
	after 2006	-0.077*	-0.168*
Heating method	REF: central heating system		
	local central heating system	0.137*	-0.344*
	heating stoves	0.089*	-0.508*
	electric (gas) stoves	-	-
	other	0.149	-0.628*

REGIONAL/CLIMATE-RELATED CHARACTERISTICS			
Region	REF: Mazowieckie		
	Dolnośląskie	-0.376*	-0.006
	Kujawsko-Pomorskie	0.080*	0.022
	Lubelskie	0.138*	-0.096*
	Lubuskie	-0.178*	0.116*
	Łódzkie	-0.153*	-0.011
	Małopolskie	-0.174*	0.033
	Opolskie	-0.395*	0.099*
	Podkarpackie	0.091*	0.106*
	Podlaskie	-0.329*	0.036
	Pomorskie	0.048*	-0.064*
	Śląskie	-0.100*	0.040
	Świętokrzyskie	0.176*	0.137*
	Warmińsko-Mazurskie	-0.167*	0.087*
	Wielkopolskie	0.116*	-0.006
	Zachodniopomorskie	-0.025	0.053
Month of survey performance	REF: January		
	February	0.023	-0.002
	March	-0.014	-0.045
	April	-0.036	-0.072*
	May	-0.057*	-0.141*
	June	-0.071*	-0.202*
	July	-0.086*	-0.186*
	August	-0.080*	-0.143*
	September	-0.076*	-0.094*
	October	-0.059*	-0.064*
	November	-0.078*	-0.065*
	December	-0.066*	-0.103*
Constant		2.473*	2.073*
R^2		37%	14%
Number of observations		15,349	17,862
Ovtest (p-value)		0.000	0.701

[1] Members of household >14 years of age.

[2] Members of household < 14 years of age.

Comment: Significance at five-percent level is indicated by *.

Source: Own calculations based on 2013 BBGD data.

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