'Club of Economics in Miskolc' TMP Vol. 7., Nr. 2., pp. 69-78. 2011.

Empirical Analysis of Public Energy Consumption – The Case of a Hungarian Village –

PETRA PETROVICS
PH.D. STUDENT

e-mail: stpetra@uni-miskolc.hu

ROLAND SZILÁGYI
ASSISTANT PROFESSOR

e-mail: roland.szilagyi@uni-miskolc.hu

SUMMARY

Global changes in recent decades have led to a demand to replace natural gas with renewable energy sources. The aim of this study is to prove that natural gas as an energy resource is not affordable in small towns or villages, which have been facing a difficult time because of socio-cultural factors and the lack of economic resources. A village in North Hungary, Csernely was selected, because its geographical and economic conditions are appropriate for implementation of this change. Csernely is a typical Hungarian small village, which is in need of development. We performed a cluster analysis and found that the proportion of 'household clusters' reflects the social stratification of villages in Hungary.

A long-term goal is to develop an energy supply model based on an alternative resource (such as biomass) that is available on location, is able to substitute for natural gas, and covers fully or partially the heat energy needs of Csernely (Szemmelveisz et al., 2011). The first step is to show that households in Csernely would benefit from the replacement of natural gas. We investigated whether there is any significant difference between the use of gas and solid fuels in the households in Csernely. We found that households are willing to use other alternative energy sources, and that the majority of them have already started to use solid fuels. However, with organized implementation, this can be more efficient and cheaper as well.

Journal of Economic Literature (JEL) code: Q42

RESEARCH AIM AND BACKGROUND

Research Aim

The aim of this research is short-term, to show that the consumption of natural gas should be replaced in the near future, mainly in small villages, such as in Csernely. A long-term goal is to find the best alternative resource that is available on location, is able to substitute for natural gas, and covers fully or partially the heat energy needs of Csernely. The final goal is to develop an energy supply model based on that alternative energy.

Background

Natural gas is one of the most popular fossil fuels, because it can be the most conveniently used for both industrial and municipal heating purposes. However, the global environmental, economic, commercial and political changes of the recent decades have led to a demand for replacing natural gas with renewable energy sources, which is an important technical, economic and social challenge.

We made a secondary research on natural gas consumption to see the relevance of our research aim and primary research. The following are some reasons to decrease the use of natural gas and replace it with other energy sources:

1. Natural gas production will continue to decrease in Hungary. According to the data of International Energy Agency, it was only 2.9 Bcm in 2010, compared with the neighbor coutries. Furthermore, the bulk of the required amount is imported, mainly from Russia. Natural gas transportation over thousands of kilometers of pipeline (see Figure 1) is risky because a system failure can cause serious supply problems, especially when it is heating season and ensuring its continuity is vital. Moreover, natural gas importers can have a huge influence – not only economic, but also political – on the country.

   According to statistics, the European OECD countries are the largest natural gas importers in the world (e.g. 1039 Bcm in 2008). Hungary requires imports as well; the quantity of imported natural gas was 48 times higher than its exported quantity in 2010. Its self-sufficiency is only 24%, which is lower than in the majority of the neighbor countries. This is summarized in Table 1.

Source: International Energy Agency (www.iea.org/gtf/index.asp; date of access: 10-12-2011)

Figure 1. Natural Gas Trade Flows in 2011

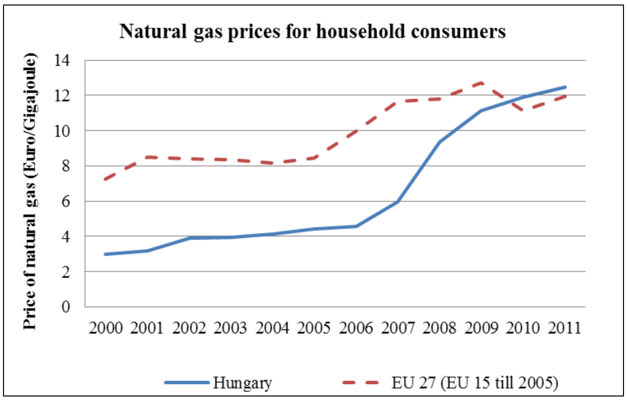
Table 1. Natural gas information (Bcm) in Hungary (2010)

Production (Bcm)	2.9
Gas demand (Bcm)	12.1
Total imports (Bcm)	9.6
Total exports (Bcm)	0.2
Total storage capacity (Bcm)	4.2
Self-sufficiency (%)	24

Source: Internaional Energy Agency, www.iea.org (Date of access: 10-12-2011)

2. The price of natural gas is growing faster than the average in the international energy market. This is particularly important from the aspect of households, because the majority of natural gas is used by the residential sector (35% in 2009), and the second largest proportion of its usage (30%) in Hungary is for electricity and heat. Prices in relation to purchasing power parity represent that a Hungarian consumer should pay more than a French, Austrian or German consumer.

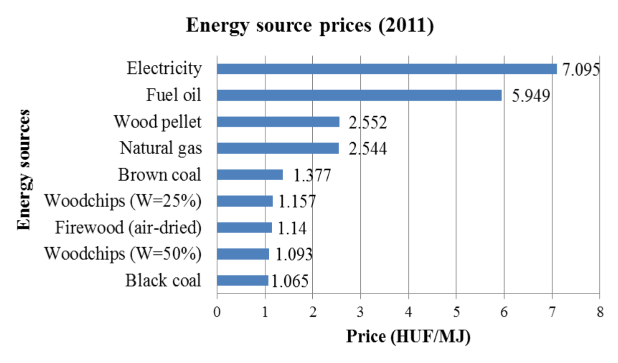
   As it is seen in Figure 2, nowadays the natural gas prices in Hungary are higher than the EU average. Hence, the majority of households cannot afford to heat with natural gas.



Source: Eurostat

Figure 2. Natural gas prices in Hungary and the European Union (2000-2011)

3. The price of natural gas is much higher than other alternative sources. The following chart represents the unit prices of energy sources per megajoule at the beginning of 2011.



Source: Szűcs et al., 2011

Figure 3. Energy source prices in Hungary (2011)

4. The storage of large quantities of natural gas is difficult and complicated, and can be implemented only under special circumstances, such as exhausted gas fields. The Hungarian total storage capacity was enough only for 35% of its total gas demand in 2010. However, according to the data of the International Energy Agency, the Hungarian total storage capacity is higher than that in the neighbouring countries.
   Natural gas can be stored for a maximum of few hours only at the place of use, and this storage requires high-volume, high pressure, and expensive equipment.
5. Carbon components of fossils emit the well-known greenhouse gas, carbon dioxide, upon combustion. According to climate experts, the main reason for global warming is the carbon dioxide emitted into the atmosphere because of the combustion of fossil fuels. Moreover, the International Convention on Climate Change obliges Hungary to reduce carbon dioxide emissions. (Point Carbon, date of access: 08-12-2011)

From 1st July, 2011, the feed-in obligation of electricity produced from gas engines was stopped, so uneconomical engines were shut down (Hungarian Energy Office). Therefore it is not worth obtaining the hot water from these engines, which is close to half of annual residential heat demand. (Szűcs et al., 2011)

In order to develop economical solutions, well-established research and development are needed, taking specific conditions and requirements into account. Besides the price of energy resources and their environmental impacts, attention should also be given to the safety of service users. That is why we carried out quantitative research in a small village in North Hungary, Csernely, to see . A further goal is to develop an energy supply model based on an alternative resource that is available on location, is able to substitute for natural gas and covers fully or partially the heat energy needs of small towns (Szemmelveisz et al., 2011).

RESEARCH METHOD

Data Collection

The empirical data collection was designed and implemented by researchers and lecturers of the University of Miskolc, also involving students. Households in Cserney were examined by primary research, using personal interviews based on questionnaires.

Csernely is a small village, which is situated in North Hungary, on the west slope of the Bükk-mountains, on the bank of the brook Csernely (www.nemzetijelkepek.hu; date of access: 15-12-2011). It has a population of 819 people (2011) on 2062 ha (website of Csernely, date of access: 12-12-2011). Because of its situation the through traffic is big. The number of true-born residents has a decreasing tendency, but the vacant households are purchased by Dutch and British citizens. The running water, gas and sewage system is developed (http://csernelyem.5mp.eu; date of access: 12-12-2011). It follows that the village has not just past and present but future as well.

The questionnaire was preceded by the compilation of a long consultation process, as expected results should serve several and sometimes different approaches of research. Ultimately, a questionnaire was drawn up containing fifty questions, both closed and open, as well as demographic, quality and metric information. The aim of this primary research was to assess every household in the village, with the abstract principle that households are places of residence during the survey. This target was not achieved because many households were left out (could not be involved) in the survey, because they were not approached or the houses were deserted. Data collection resulted in almost 65% of the population households as a sample (222 out of 350; http://csernelyem.5mp.eu; date of access: 12-12-2011). Representativeness is defined in the expectation in the planning of sampling and in choosing the sampling process, and not only in the case of stratified samples. In practice, representativeness is expected from the intake based on numerous parameters.

Our study did not seek to make national or generalized conclusions, and therefore the lack of representativeness does not limit the analytical potential and applicability of results.

Data Organization

According to the number of completed, usable questionnaires we found that the error is significant when drawing conclusions. Far fewer questionnaires were obtained than expected, so not all households were observed in the village, which is a non-sampling error of the research.

This error partly comes from the incorrect definition of population. This problem often occurs during data collection, as practical research has rarely reference to well-defined, clearly designated populations. There are several residential properties located in the village which are not occupied, but this turned out only on the occasion of the personal visit. Such properties should not form part of the framework of the underlying population, since they are not relevant, either from the aspect of energy use nor any other research topic.

On the other hand, we had non-sampling error because of non-responses due to the lack of interest in the population. Based on domestic and international research findings, we can state that the biggest problem when carrying out surveys is when answers are not given. Some authors argue that the extent of this may exceed the rate of sampling error in some cases (Hunyadi and Vita, 2002). However, if we know and take into account the non-response rate, it improves the interpretation of statistics.

This type of error can the most effectively be reduced by prevention; therefore the members of the research team took measures to reduce the error. Before the personal visit, the population was informed about the exact time and purpose that they would be visited by an interviewer. The interviewers were educated about effective communication, confidence-inspiring appearance, and the importance of patient cooperation. Based on our experience, we can say that in general the aloofness of the elderly prevented the data collection. Older residents are likely to distrust outsiders or be reluctant to discuss financial matters. This negative impact was intensified by the demographic structure of the village, which shows an aging population, mostly composed of pensioners.

Aside from the non-sampling error above, the error resulting from data collection and data fixing was negligible, since it was eliminated and improved by using effective data management.

However, partial non-response resulted in significant disruption to the analytical work as well. Namely, in some of the households the respondent did not possess the required information, or did not wish to answer. To reduce the partial non-response, imputation was used. Unfortunately, the implementation of complex multivariate imputation was not possible because there were too many variables with missing data, which would have provided inputs into the regression.

For the imputation of demographic variables – instead of the grand mean imputation – more sophisticated imputation based on partial means was used. On the basis on external information imputation groups were created, their averages were defined, and then missing values were supplemented with the average of the corresponding groups. In the case of economic variables and other metric variables, more complicated procedures were needed.

In national statistical surveys, such as the Household Budget Survey's expenditure items, the principle of similarity (hot deck) imputation is used to replace data. The similarity-based methods can be applied if the sample elements (in this case, households) show similarity according to different variables. The essence of hot deck imputation is to find data about the most similar individuals to individuals containing missing data in which the required data is available, and then replace missing values with them. There are several techniques to define the extent and aspects of similarities (Mahalanobis distance, squared Euclidean distance, etc.).

We separately defined discriminant functions for variables containing missing values using discriminant analysis by several predictor variables, which helped in the separation of respondents from non-respondents. To measure the discriminatory effect, Mahalanobis distance measure was used, thereby selecting the most similar households to each other. The following were the independent variables of analysis:

- gender of the head of family;
- age of the head of family;
- activity status of the head of family;
- number of rooms;
- household size;
- income category.

Using stepwise method, variables showing significant correlation with the discriminant function were selected from these variables. Although the results are considered statistically significant according to the Wilk's lambda, based on the canonical correlation coefficients it was below 0.5 (e.g. 0.394) in some cases. Classification results showed that in case of each variable which should be imputed, the hit ratio (correct classification) was approximately 70-90%. However, the use of results is limited, since a higher proportion of respondents are correctly identified. The SPSS program saves the estimated function values and Mahalanobis distances, so imputation could be used. In those cases when several individuals with the same distance belonged to non-respondents, the average value of these individuals was imputed.

DATA ANALYSIS

First of all, testing the imputation, we used discriminant analysis. This is a multivariate method that helps to predict the classification of cases into groups (here: respondents vs. non-respondents) on the basis of independent variables. The analysis helps in deciding whether the groups differ significantly from each other, and which variables cause this difference. From this, we can estimate which case will belong to which group. Therefore, discriminant analysis is an extremely useful analytical method in market research. For more detailed description of the method, see also Székelyi and Barna

(2002), Szűcs (2002), Sajtos and Mitev (2007), and Ketskeméty and Izsó (2005).

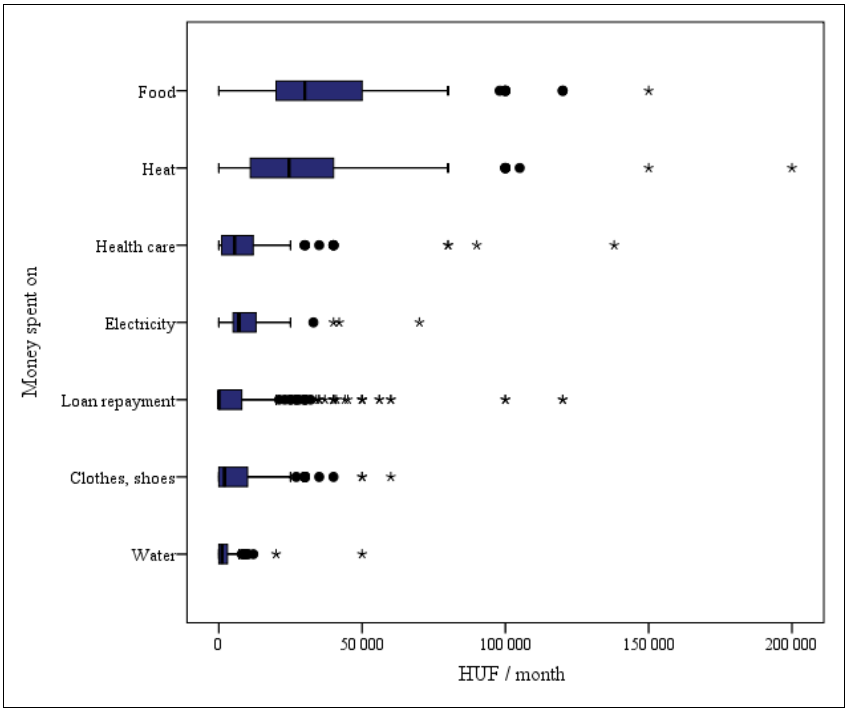
The households in Csernely were generally analyzed by the measures of descriptive statistics (such as mean, mode, median, quartiles, standard deviation and asymmetry) and measures of stochastic dependence among variables. When both the dependent and independent variables were nominal or geographical variables, we analyzed them by cross-table analysis (using Cramer measure, adjusted residual statistics, odds ratio and risk metrics). When the dependent variable was quantitative and the independent was qualitative, we used analysis of variance with F-statistics. In the case of quantitative dependent and independent variables, we analyzed the relation by correlation and regression analysis. However, sometimes the dependent variable was a discrete, categorical one; this was classification.

The composition of households was analyzed by cluster analysis. Cluster analysis is a dimension reduction method that aims to show that there are groups where within-group distance is minimal, since cases are more similar to each other than to members of other groups (Varga and Szilágyi, 2011). We used hierarchical cluster analysis, because it provides more choices than a simple illustration, such as distance and similarity measures, further methods, and the definition of ideal number of clusters. It is a series of cascading steps, which defines clusters according to the previous cluster solutions as long as we get the ideal number of clusters. After testing the assumptions of the analysis, we used the Ward method, because it is the most frequently used method in case of economic calculations. It can be used in case of metric variables. The cluster to be merged is the one which will minimize the increase in within-group variance (Sajtos and Mitev, 2007). This method tends to create small and similar-sized, homogenous clusters. The method is sensitive to outliers, therefore we eliminated them. The validity of clusters was tested by non-hierarchical cluster methods and discriminant analysis. For more detailed description of method, see also Falus and Ollé (2000), Sajtos and Mitev (2007) and Ketskeméty and Izsó (2005).

For data analysis, we used Microsoft Excel 2010 and the SPSS 19.0 statistical program.

RESULTS

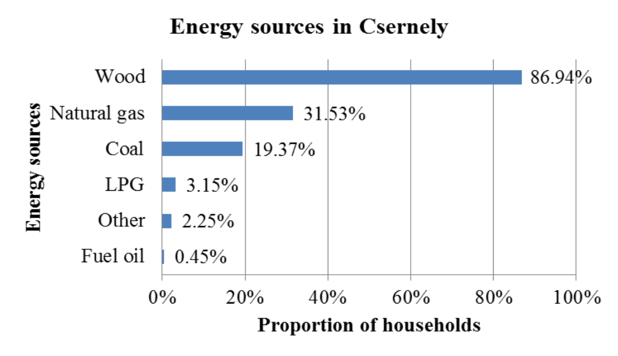
Our hypothesis was that natural gas should be replaced in Csernely. To prove this, first of all we analyzed the households by quantitative statistical methods. We found that the average spending on heat is the second largest expenditure (27582.57 ± 25660.46) after the average spending on food (35524.77 ± 24978.92). The boxplot of households' monthly expenditure is represented in Figure 4.



Source: Own creation according to own research, SPSS 19.0

Figure 4. Average monthly expenditure per household in Csernely (n=222)

Moreover, we investigated the proportion of energy sources used in Csernely, and we found that wood is the most frequently used source (86.94%) in households, followed by natural gas (31.53%), as shown in Figure 5. However, 67.7% of households use only solid fuels and 11.4% of them heat only with gas, while 20.9% of respondents heat with solid fuels and gas or other fossil fuels as well.



Source: Own creation according to own research

Figure 5. Energy sources used in Csernely (n=222)

Then we investigated whether there is any significant difference between the use of gas and solid fuels in the households in Csernely. For nominal variables, we used cross-tab analysis: chi-square test and Cramer's V measure. Furthermore, an examination of residuals could tell us more about how the model fails to fit. The adjusted residual is the observed minus expected value divided by an estimate of its standard error, which is expressed in standard deviation units above or below the mean (SPSS Tutorial 19.0). According to a rule of thumb, an adjusted residual greater than or equal to 2 is regarded as significant. So the major differences between households using gas or solid fuel on the basis of the calculations described above are summarized in Table 2. Only significant relations ($p<0.1$) are represented.

Table 2. Nominal characteristics of households in Csernely according to the type of heating

Characteristics (p<0.1)	Heat with	
	Mainly Gas (n=71)	Solid Fuel (n=149)
Type of house	Semi-detached house	Farmhouse
Number of rooms in the house	3	1-2
Running water	There is	None
Hot water	There is	None
Sewage	There is	None
Flush toilet	There is	None
Bathroom	There is	None
Debt	Not have	Have
Heard about renewable energy?	Yes	No

Relationships are available where the Adjusted Residual is ≥ 2.

Source: Own creation according to own research

According to the results, people heating mainly with gas typically live in a 3-room, well-equipped semi-detached house and have no debts. This means that those people use gas who can afford to do so. The major users of solid fuels are those living in farmhouses.

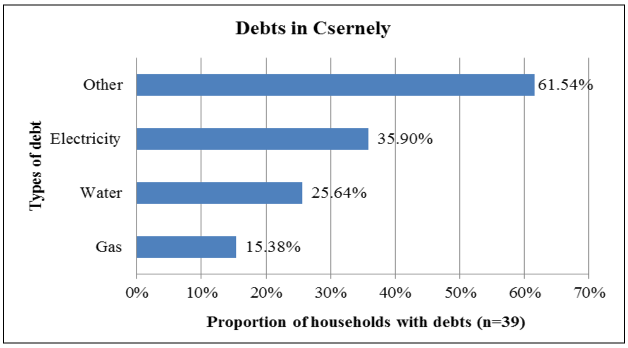
Moreover, we tested whether the probability of heating with gas is the same for two groups. For this, we defined odds that describe the strength of association between two binary values. An odds ratio is used to compare the odds for the two groups, as shown in Table 3.

Table 3. Different odds ratios for gas vs. solid fuel heating in Csernely

Parameter (p<0.1)	Odds ratio (Gas/Solid fuel)	CI 95%
There is running water	4.391	2.027; 9.510
There is hot water	3.803	1.751; 8.259
There is sewage	3.477	1.688; 7.159
There is flush toilet	3.479	1.599; 7.570
There is bathroom	3.130	1.321; 7.418
Have debt	0.475	0.206; 1.095

Source: Own creation according to own research

These ratios mean that using gas is at least 3 times more likely than using solid fuel in those houses where there is running water, hot water, sewage, a flush toilet or a bathroom; while it is more than twice as likely for households who have debt to heat with solid fuels.



Source: Own creation according to own research

Figure 6. Types of debt in Csernely

From Figure 6 we can see that 15.38% of households that have debts are indebted because of gas heating, while for 35.9% of them it is due to their debts for electricity.

As we can see from Table 4, according to the metric characteristics of households, the most significant difference between using gas or solid fuels is the age of the head of household. On the average, the head of households is older than the average in those households where they use mainly gas instead of solid fuels. Moreover, the average floor space, average health care expenditure and the average quantity of garbage have a significant relation to the type of energy used.

To enhance the efficiency of research and for better use of database information, we attempted to explore the hidden structure of households (population). According to our hypothesis, the structure that can be discovered in the households will help in a more detailed analysis of energy consumption habits and rates. Indeed, different conclusions are related to homogeneous groups of households with different demographic and economic characteristics. For this, we analyzed the composition of households by cluster analysis.

Table 4. Metric characteristics1of households in Csernely according to the type of heating

Characteristics	Total (n=220)	Heat with Mainly Gas (n=71)	Heat with Solid Fuel (n=149)	P value of ANOVA (<0.350)
Age of head of household	58.00 ± 16.61	65.70 ± 14.25	54.34 ± 16.44	0.000
Floor space (m^2)	86.28 ± 43.51	97.14 ± 42.46	81.10 ± 43.19	0.011
Average amount spent on health care (HUF/month)	9511.59 ±14896.03	13180.99 ± 20365.22	7763.09 ± 9994.48	0.011
Garbage (liters/week)	88.56 ± 90.88	103.06 ± 133.35	81.73 ± 61.03	0.119
Average amount spent on food (HUF/month)	35325.00 ± 24947.89	32584.51 ± 20497.38	36630.87 ± 26775.81	0.262
Monthly income (HUF/month)	115775.5 ± 70971.36	123415.21 ± 77448.26	112135.10 ± 67638.43	0.271
Average amount spent on electricity (HUF/month)	9231.35 ± 7582.51	8497.07 ± 5082.13	9581.25 ± 8513.43	0.323

[1] mean ± standard deviation

Source: Own creation according to own research

The first task was to find variables that lead to similarity between households, show a stochastic relation with energy use and do not correlate with each other. As using uncorrelated (or weakly correlated) variables is an assumption of cluster analysis, this was the main aspect of variable selection. Results are given in Table 5. According to the results of the correlation matrix, there is no strong correlation, and most results significantly differ from zero.

According to the results of correlation matrix, there is no strong correlation, and most results significantly differ from zero.

Testing further assumptions, we did not discover any outliers in the data set. The classification clearly resulted in one solution of three homogeneous groups. One of the clusters represents people with an average or above-average standard of living – the well off group – while the members of the second group have a lower standard of living, they are the poor[1]. The third group is a small group mainly made up of households of the elderly.

We believe that results of clusters can be further refined if we have appropriate information, which is unfortunately not available for this study because of the limitations of the data set. For the validation of cluster analysis, we performed an analysis of variance on the following metric, economic and demographic variables:

- Age of the head of household;
- Household size (persons);
- Number of rooms;
- Total expenditure of households;
- Income of households.

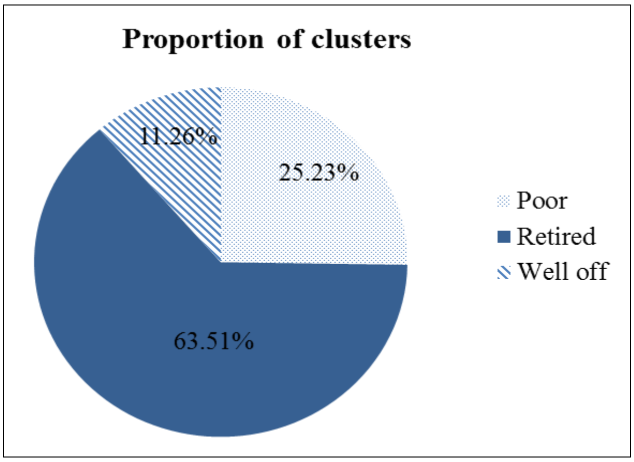
Significant differences between the averages of households were proved by Dunnett's T3 Post Hoc test. Group averages of different types of households significantly differed for nearly all variables, and only one aspect was an exception: the average income of the poor and pensioners was close. This phenomenon does not indicate incorrect classification, but rather confirms the actual socio-economic conditions of Hungarian villages.

Table 5. Correlation matrix of underlying variables for cluster analysis

		Number of rooms	Average monthly income	Number of household members
Number of rooms	Pearson Correlation	1	0.274**	0.027
	Sig. (2-tailed)		0.000	0.688
	N	222	222	222
Average monthly income	Pearson Correlation	0.274**	1	0.310**
	Sig. (2-tailed)	0.000		0.000
	N	222	222	222
Number of household members	Pearson Correlation	0.027	0.310**	1
	Sig. (2-tailed)	0.688	0.000	
	N	222	222	222

**. Correlation is significant at the 0.01 level (2-tailed).

The proportion of households belonging to different clusters accurately reflects the social stratification of villages in the country (see also HCSO), which is represented on the pie chart in Figure 7.



Source: Own creation according to own research

Figure 7. Proportion of household clusters

[1] *Under the term "standard of living" we do not necessarily mean the correct, classical economics, statistical formulation, but a description of living conditions on the basis on variables available in the database.*

As the validation of cluster analysis showed, households of the 'well off' cluster have a higher income, mid-sized households and relatively large residential property. In addition, a high proportion of cluster members graduated from secondary school or higher education. Besides the main income of the head of the household, additional jobs or higher pensions contribute to the relatively high income of households. The financial stability of cluster members is proved by the fact that only three households have debts toward a service provider.

In contrast, 'poor' household members are younger, on the average. The typically larger (more than 4 members on the average) households in the cluster have only two rooms, reflecting their financial situation. These households have usually more expenditure than income in a month, so they built up the largest ratio of debt in Csernely. Their highest level of education is vocational or technical school, but the majority of them finished only eight years of primary school, or have even less education. Their income mainly comes from casual work, unemployment benefits, and child care benefits.

The largest group is the cluster of pensioners. These households have relatively the lowest income and also the lowest expenditures in the village. The main reason is that usually a household of this cluster contains a maximum of two members, where the average age is 64 years. The frugal lifestyle of pensioners in a village is demonstrated, because in comparison to their low income their expenditures are low as well, and only 10% of them have some kind of debt. However, relatively large (2-3 rooms) residential property belongs to these small households, which requires a relatively high cost of maintaining.

Concerning the energy use characteristics of the household clusters, significant differences can be found in the amount of energy use and awareness of the developments in the energy sector.

Table 6. Cross-tabulation of type of heat and household clusters

Type of Heat		Household Clusters			Total
		Poor	Retired	Well off	
Gas	Count	3	19	3	25
	Proportion (%)	12.00	76.00	12.00	100
	Adjusted Residual	-1.6	1.4	0.1	
Solid Fuel	Count	49	87	13	149
	Proportion (%)	32.89	58.39	8.72	100
	Adjusted Residual	**3.9**	-2.3	-1.8	
Gas and Solid Fuel	Count	3	34	9	46
	Proportion (%)	6.52	73.91	19.57	100
	Adjusted Residual	-3.3	1.6	**2.0**	
Total	Count	55	140	25	220

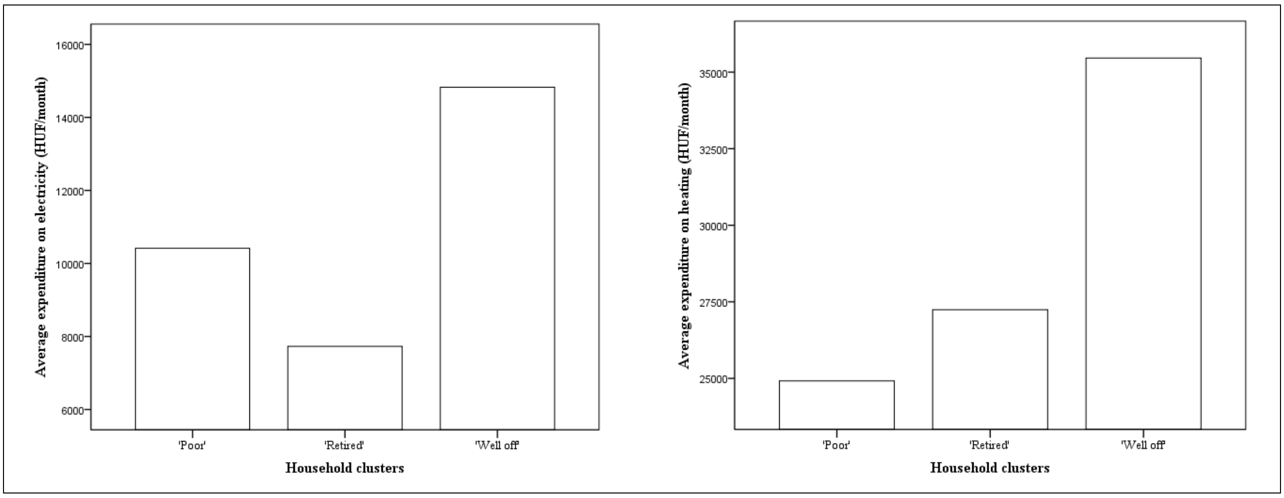
Source: Own creation according to own research

During the analysis of heating energy consumption, as shown in Table 6, we found that the majority of 'poor' households use solid fuels. Pensioners are the largest group of gas consumers in Csernely, because besides the convenience of gas heating (it does not require any physical effort, such as cutting wood, carrying, etc.) partial heating of residential buildings can be easily solved. This is the major advantage of gas heating in contrast to central heating (either solid or gas), resulting in cost savings, and it makes gas heating popular for one-person and typically retired households. Analyzing the internal ratios in case of heating in wealthy households, we found that they typically have the option of both solid and gas heating installation.

From the aspect of environmental improvements, people living in small villages are usually not informed and also not interested. The reason for this is that information of public interest and communication systems dealing with environmental issues – particularly because of pollution concentration in large cities – do not consider the inhabitants of small towns as an intended target group. Apart from the wealthy households, the other two clusters have hardly even heard about renewable energy sources. Moreover, only 10% of households dispose of their waste selectively. Thus, without more specified future goals, centralized management and effective communication, the implementation of environmentally friendly energy use has very little chance.

Studying the energy use of household clusters, we focused on the characteristics of electricity and heating energy use, because these two are the largest items in residential use. (The transportation energy use was not relevant, precisely because of the demographic composition. Mainly people live in Csernely who seldom leave the village.)

The differences in energy consumption of each cluster are well detected in both types of energy. The 'wealthy' households consume significant quantities of both electricity and energy for heating compared to other clusters. The retired households have exactly the opposite consumer behaviour, because they have low energy consumption from both types. In the case of the poor households, no such conclusions can be drawn. Heating, as a major cost item of households, is very low for poor households. This is due to the use of solid fuels. Some of the winter fuel can be gathered from the garden, agricultural waste and from the nearby forests. In addition, burning waste is significant (which is, unfortunately, without any selection), including burning environmentally harmful materials as well. Thus, the cost of energy spent on heating can be minimized. In contrast, electricity consumption is much higher for poor than for retired people. The purchase of electricity is determined by technical evolution; on the one hand, it cannot be produced at home, or replaced with anything. It can be concluded that the average monthly expenditure on electricity is strongly correlated to the level of other expenditures, while average expenditure on heat is not. The total expenditure of the 'poor' group is higher than in the case of pensioners, while lower than for 'wealthy' people. The same relation can be observed in electricity consumption as well. Thus considering the distribution of actual energy consumption, the electricity consumption shows a more realistic portfolio than the heating costs, which take up a larger proportion within total expenditures. Therefore, further research can be the analysis of electricity consumption in more detail.



Source: Own creation according to own research

Figure 8. Average expenditure on electricity (left) and heating (right) by type of household cluster

CONCLUSION

Analyzing the questionnaire asked in Csernely, we found that the average spending on heat is the second largest expenditure of households. More than half of households with debts are indebted because of gas heating or electricity.

A cluster analysis showed that three clusters exist in the village: the poor, the retired and the well off clusters. The proportion of 'household clusters' reflects the social stratification of villages in Hungary.

We investigated whether there is any significant difference between the use of gas and solid fuels in the households in Csernely. The major difference is that mainly well off people heat with gas, because of its price. Wood is the most frequently used energy source (86.94%) in households, followed by natural gas, however the majority of households uses combined heating. We found that households are willing to use other alternative energy sources as well. However, with organized implementation, this can be more efficient and cheaper. Therefore households in Csernely would benefit from the replacement of natural gas.

This study is the base of further investigations. Since people are willing to (or have to) replace natural gas, a research about alternative resources (such as biomass) – which are able to substitute for natural gas, and covers fully or partially the heat energy needs of Csernely – is required.

Acknowledgements

The described work was carried out as part of the TÁMOP-4.2.1.B-10/2/KONV-2010-0001 project in the framework of the New Hungarian Development Plan. The realization of this project is supported by the European Union, co-financed by the European Social Fund.

REFERENCES

Csernely's Official Website: Csernely története: http://csernely.hu/csernelyrol/csernely-tortenete (Date of access: 15-12-2011)
Csernely: http://csernelyem.5mp.eu/web.php?a=csernelyem&o=eQ9ZLdxX4J (Date of access: 12-12-2011)
Csernely: National and Historical Symbols of Hungary: http://www.nemzetijelkepek.hu/onkormanyzat-csernely_en.shtml (Date of access: 15-12-2011)
Eurostat: Statistics / Environment and energy / Energy / Database:
http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/themes (Date of access: 10-12-2011)
FALUS IVÁN – OLLÉ JÁNOS: Statisztikai módszerek pedagógusok számára; Okker kiadó, 2000.
HOMOLA Viktor: Energia és környezet – Az egyensúly lehetséges!, Energiagazdálkodás, 43. évfolyam, Budapest, 2002/5. p. 17-21.
HUNYADI LÁSZLÓ – VITA LÁSZLÓ: Statisztika közgazdászoknak. Központi Statisztikai Hivatal, Budapest, 2002
International Energy Agency: Statistics / Natural Gas / Map energy indicators: http://www.iea.org/gtf/index.asp (Date of access: 10-12-2011)
KETSKEMÉTY LÁSZLÓ – IZSÓ LAJOS: Bevezetés az SPSS programrendszerbe; ELTE Eötvös Kiadó, Budapest, 2005.
Point Carbon: Carbon market overview: http://www.pointcarbon.com/aboutus/productsandprices/1.266920 (Date of access: 08-12-2011)
SAJTOS LÁSZLÓ – MITEV ARIEL: SPSS kutatási és adatelemzési kézikönyv; Alinea Kiadó, Budapest, 2007.
SPSS Tutorial, 19.0, IBM Software
SZEMMELVEISZ TAMÁSNÉ: Fás- és lágyszárú biomasszák tüzelhetőségi feltételeinek vizsgálata. Doktori (PhD) értekezés, Miskolci Egyetem, Műszaki Anyagtudományi Kar, Tüzeléstani és Hőenergia Tanszék, 2006.
SZEMMELVEISZ TAMÁSNÉ – KOVÁCS HELGA – KOÓS TAMÁS: The role of biomass in the heat energy supply of small towns. Anyagmérnöki Tudományok, 36/1, Miskolc, 2011.
SZÉKELYI MÁRIA – BARNA ILDIKÓ: Túlélőkészlet az SPSS-hez; Typotex Kiadó, Budapest, 2002.
SZŰCS ISTVÁN: Alkalmazott statisztika; Budapest, 2002.
SZŰCS ISTVÁN et al.: Földgáz alapú fűtőműi hőtermelés és távhőellátás kiváltása biomassza tüzeléssel, környezetbarát transzporttal. A miskolci távhőszolgáltatás kiterjesztésének és a tisztán földgáz alapú hőtermelés megújuló energiahordozókkal történő részbeni helyettesítésének vizsgálata. 3. kötet. 2011. p. 12-15., (www.miho.hu/_downloaddoc.php?docid=85&mode=documents; date of access: 10-12-2011)
VARGA BEATRIX – SZILÁGYI ROLAND: Quantitative Information Forming Methods:
http://miskolc.infotec.hu/ilias.php?baseClass=ilSAHSPresentationGUI&ref_id=1273, 2011. (Date of access: 10-12-2011)