DETERMINATION OF HOUSEHOLDS ENERGY CONSUMPTION AS A PART OF REGIONAL ENERGY PLANING

Bernard Franković, Kristian Lenić
Faculty of Engineering, University of Rijeka
Vukovarska 58, 51000-Rijeka, Croatia

ABSTRACT

In the paper the household energy consumption analysis as part of regional energy planning has been presented. Research has been performed for the area of Primorsko-goranska County, Croatia. The analysis was based on a survey of households using a spatial division methodology. For this purpose, the region has been spatially divided into 14 zones based on geographic, climatic and economical characteristics as well as different population concentration and urbanization. Analysis included the calculation of final energy consumption for the whole region and for each single zone. Furthermore, the final energy consumption has been analyzed regarding energy sources and use of this energy for space heating, domestic hot water preparation, cooking and non-thermal usage. In addition, some parameters have also been presented, depending on living standard, but also related to energy consumption, such as number of household members and possession of household devices and cars. The results of the research are a base for the gasification project of the region.

1. INTRODUCTION

The gasification project of Primorsko-goranska County in Croatia, includes research and calculations of total final energy requirements in households, industrial and public service sectors of the County. A survey of energy needs was the base for the calculation of final energy consumption in households. A survey sample encompassed 2083 households and every household was represented by one questionnaire sheet. This representative sample comprises 1.8 % of total households in Primorsko-goranska County and about 2% of inhabitants. For this purpose, the region was spatially divided into 14 zones based on geographic, climatic and economical characteristics as well as different population concentration and urbanization. The number of surveyed households in a zone was calculated from the percentage of number of inhabitants, except for those zones with a low number of inhabitants, where a minimal required representation sample (50 households) was adopted. The Municipality of Rijeka area has been divided into five zones. These area divisions have no connection with administrative boundaries, but serve mainly for a detailed and more accurate calculations and presentations of energy requirements. Zones are shown in figure 1 and table 1.

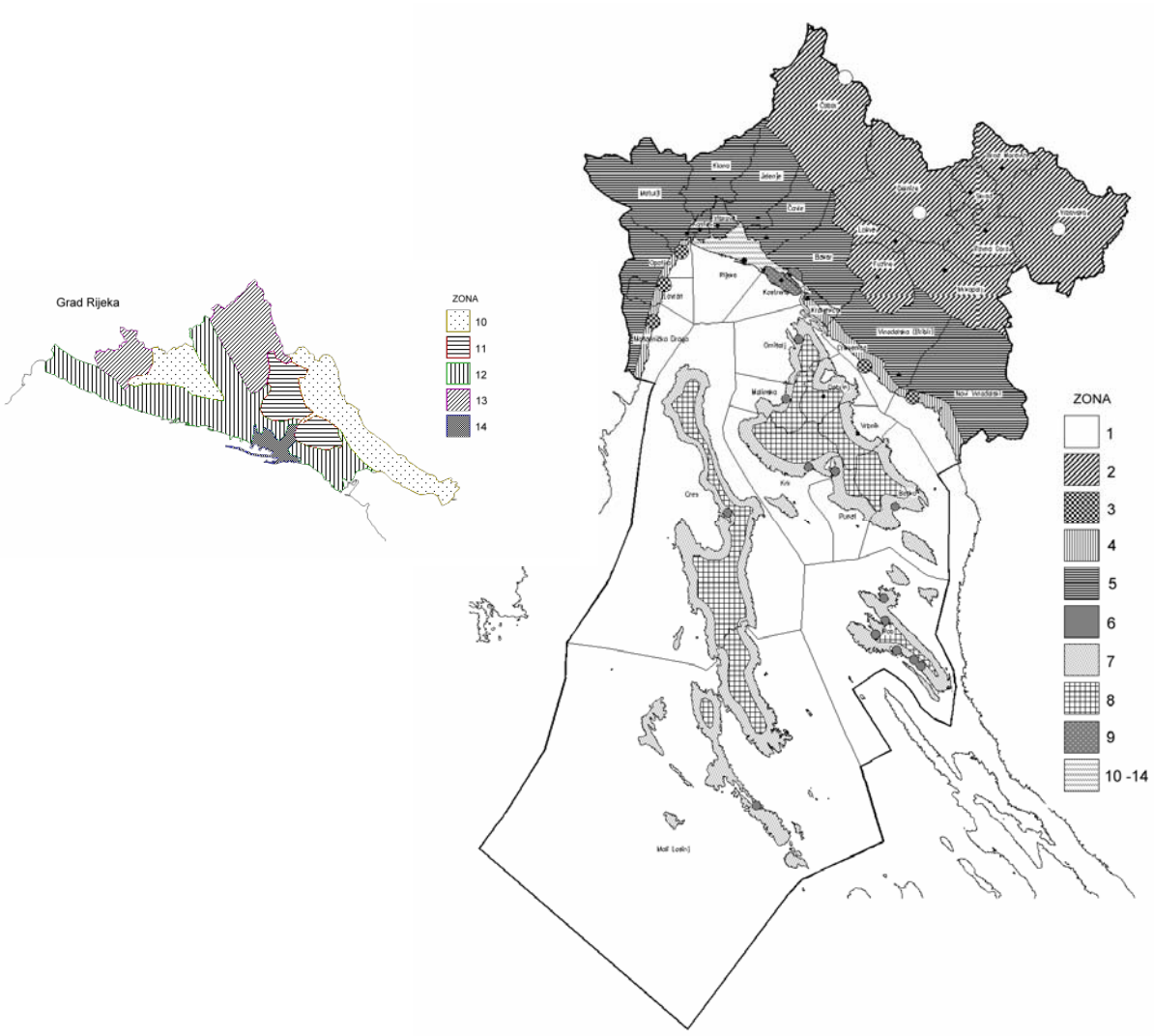

Figure 1. Disposition of survey zones in the territory of Primorsko-goranska County

Table 1. List of survey zones

Zone	Description	No. of inhabitians	surveyed households
1	Urban centers of Gorski kotar	7340	50
2	Gorski kotar without urban centers	23205	142
3	Touristic centers on the coast	26524	166
4	Coast without touristic centers	8483	53
5	Coastal hinterland	50524	313
6	Touristic settlements on the coastal region of islands	27716	173
7	Other settlements on the coastal region of islands	4533	50
8	Settlements in the hinterland of islands	5154	50
9	Kostrena and Bakar	5576	50
10	Rijeka – predominantly family houses without gas pipe network	15176	94
11	Rijeka – predominantly family houses with gas pipe network	4660	50
12	Rijeka – predominantly flats without gas pipe network	114520	707
13	Rijeka – predominantly flats with gas pipe network	14490	90
14	Rijeka – older center with gas pipe network	15229	95
	TOTAL FOR COUNTY	323130	2083

2. RESULT OF ANALYSIS

2.1 General analysis

The number of household members is one parameter that influences household energy consumption. The average number of household members for the whole survey sample in Primorsko-goranska County is found to be 3.28. Figure 2 shows the average number of household members for analyzed zones and figure 3 gives a breakdown of the different household members in surveyed households.

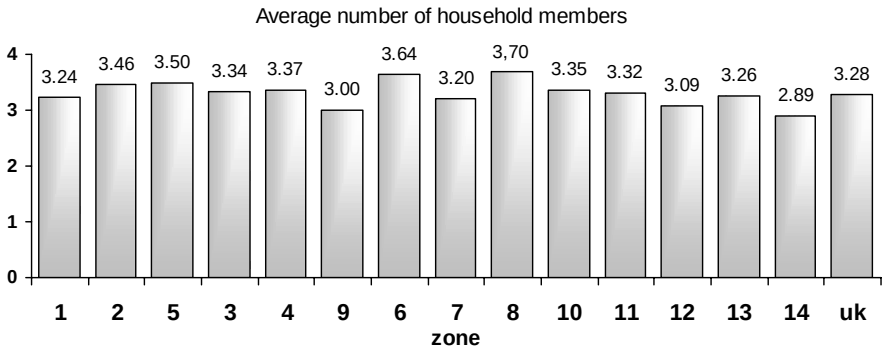

Figure 2. Average number of household members

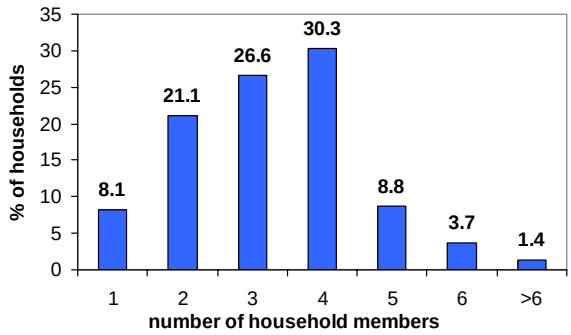

Figure 3. Breakdown of households with different number of members

Usage of different household devices strongly influences household energy consumption. The breakdown of household devices usage in surveyed sample of households as well as ownership of cars is shown in figure 4. It can be seen that 60% of households possess one car, but nearly 13% of households in the County uses two or more cars. The ratio of household telephone line connections is high, 93.5%; in contrast, the air conditioning devices are used only in 1.8 % of households.

2.2. Analysis of energy consumption

2.2.1. Total annual final energy consumption in households

Total annual final energy consumption of households in Primorsko-goranska County is about 5.4 PJ. The total final energy consumption in every group of zones is shown in figure 5. Furthermore, the final energy consumption regarding energy sources has also been presented in the same figure. It can be noted that in the area of Gorski kotar and the littoral hinterland

(zones 1,2 and 5) 61% of total final energy is provided from fuel wood. In coastal regions the rate of fuel wood in final energy consumption drops to 38% on the coast (zones 3,4 and 9) and 27% of total final energy consumption on islands (zones 6,7 and 8). In the Municipality of Rijeka the greatest proportion in final energy consumption is occupied by electrical energy (44%), in addition, fuel wood (28%) and district heating (12%) follows.

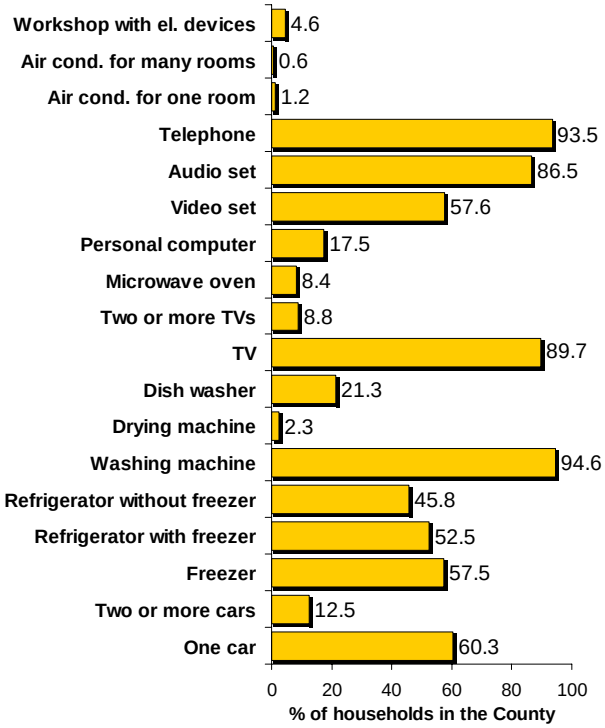

Figure 4. Usage of different households devices and car ownership

2.2.2. Final energy consumption for space heating

In the whole area, except for the islands, fuel wood occupies a major proportion in final energy consumption for space heating, especially in the area of Gorski kotar and littoral hinterland (zones 1,2 and 5) with a share of 75%, on coastal region (zones 3,4, and 9) 61% and on islands (zones 3,4 and 9) 44%. In the Municipality of Rijeka the proportion of fuel wood in final energy consumption for space heating is 45%, followed by electricity (18%), and district heating (17%).

2.2.3. Final energy consumption for sanitary hot water (SHW) heating

The greatest part of final energy consumption for sanitary hot water heating in households is allocated to electricity, especially in the coastal region (zones 3,4 and 9) where the proportion of electricity in final energy consumption for SHW heating is 91%. On the islands (zones 5,6,8) electricity provides 71% of final energy for SHW preparation. In the area of Municipality of Rijeka (zones 10-14) this proportion is lower and correspond to 67%, while district heating provide 17% of energy. The biggest parts in final energy consumption

for SHW heating in the regions of Gorski kotar and littoral hinterland (zones 1,2,5) are allocated to fuel wood (53%) and electricity (39%).

2.2.4. Final energy consumption for cooking in households

The mayor proportion of final energy consumption for cooking in households situated in coastal regions (zones 3,4,9) and on islands (zones 6,7,8) is allocated to LNG. In households located in Gorski kotar and the coastal hinterland, 58% of final energy for cooking is provided by fuel wood. In the Municipality of Rijeka the final energy requirement for cooking consist of electricity (37%), fuel wood (27%), LNG (20%) and gas from pipe network with a proportion of 16%.

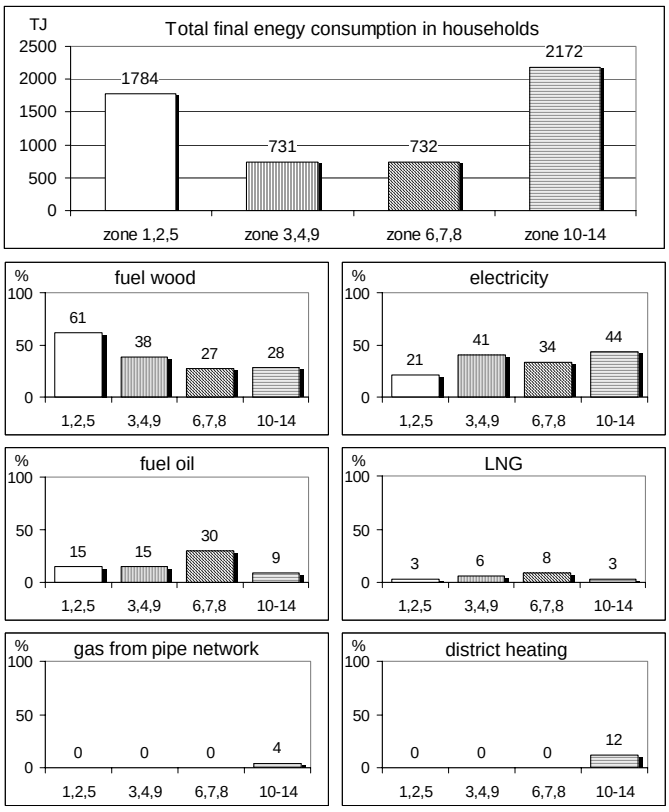

Figure 5. Total final energy consumption in households with respect to different energy sources

2.2.5. Final energy consumption structure

The major parts of total final energy consumption are provided from fuel wood with an amount of about 40% and from electricity with 35%. Furthermore, total final energy consists of fuel oil with a proportion of about 15%, district heating 5%, LNG 4% and pipe network gas with 1,5%. The structure of final energy consumption in households with respect to energy sources and energy usage is shown on figure 6.

The greatest part of total final energy consumption in households is used for space heating with proportion of 59%. About 17% of final energy requirements are used for non-thermal needs, 13% for sanitary hot water preparation and 11% for cooking in households.

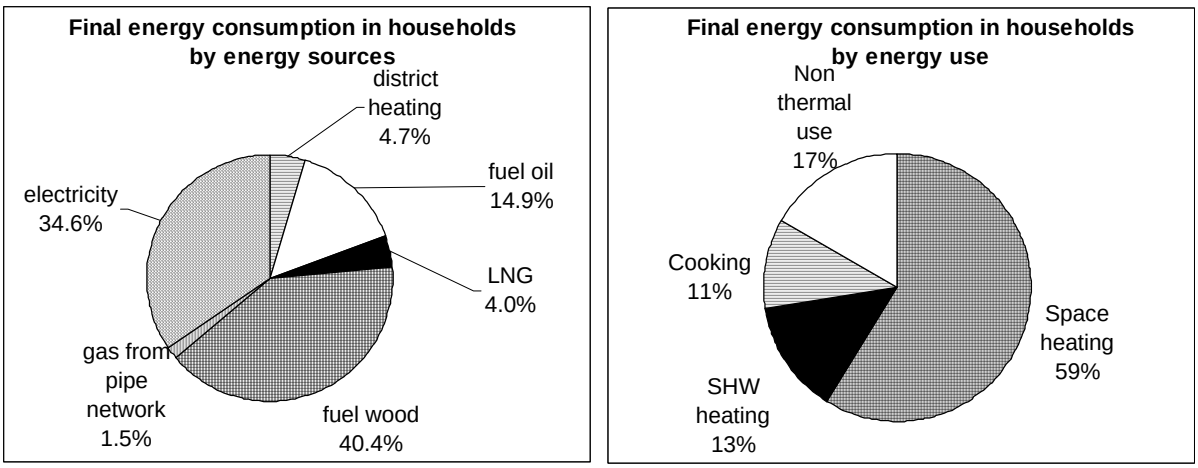

Figure 6. Structure of final energy consumption in households by energy sources and by energy use

The structure of energy sources for each segment of energy usage is shown in figure 7. It can be noted that fuel wood represents a major energy source for space heating in households. Then follows fuel oil and electricity. The final energy for SHW preparation in the major part is provided from electricity and fuel wood. Fuel wood, LNG, electricity and pipe network gas respectively are used as main energy sources for cooking in households.

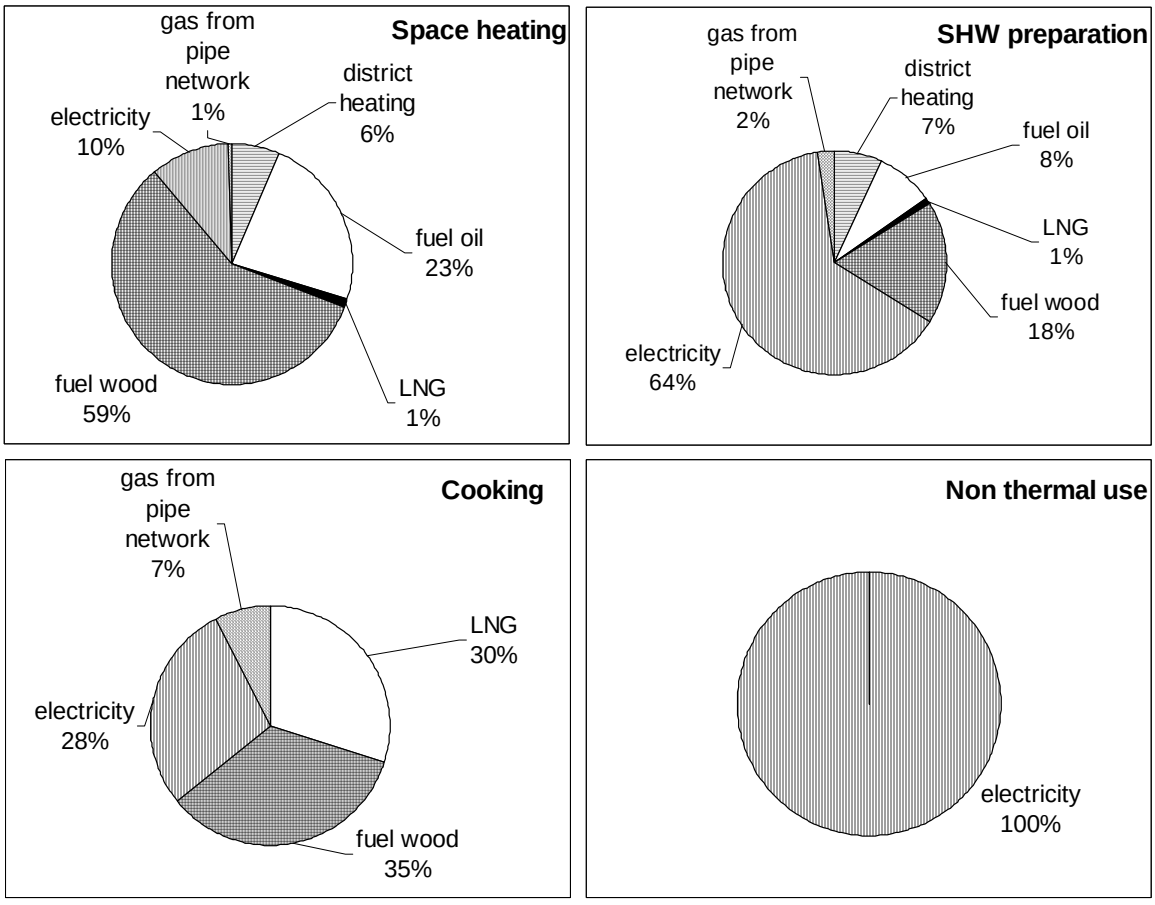

Figure 7. Structure of energy sources for each segment of energy usage

3. CONCLUSION

The given structure of final energy consumption in households situated in the region of Primorsko-goranska County shows that only 80 TJ or about 1,5% of energy is provided from gas pipe network. A similar analysis for the area of the Municipality of Rijeka shows that this energy source gives only 3,7% of total final energy needs of households. The results of household final energy consumption analysis and calculation of energy consumption in industry and service sectors, are bases for prediction of energy requirements in the County. Areas where the new gas pipe network will be worth while can be determined, from energy demand predictions and estimated capital cost for gas pipe network, using a feasibility analysis. The results of the research are a base for the gasification project of the region.

LITERATURE

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