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Določanje porabe energije gospodinjstev v okviru regionalnega načrtovanja porabe

The Determination of Household Energy Consumption as a Part of a Regional Energy Plan

Bernard Franković - Kristian Lenić

V tem prispevku je analizirana poraba energije gospodinjstev v okviru regionalnega načrtovanja porabe. Raziskava je bila opravljena za Primorsko-goransko območje na Hrvaškem. Ta analiza je temeljila na raziskavi gospodinjstev z metodo prostorske razdelitve. Za ta namen je bila regija posebej razdeljena v 14 con, ki so bile določene glede na geografske, klimatske in ekonomske značilnosti kakor tudi glede na različno gostoto poseljenosti in urbanizacije. Analiza je obsegala izračune za celotno porabo energije za celotno regijo in tudi za vsako posamezno cono. Še več, analizirali so energijske vire in uporabo le-te za ogrevanje, pripravo tople sanitarne vode, kuhanje ter drugo. Predstavljeni so bili tudi nekateri parametri, npr.: število družinskih članov, gospodinjskih aparatov ter avtomobilov, ki so odvisni od življenjskega standarda, toda so tudi v povezavi s porabo energije. Rezultati te raziskave so osnova za pripravo projekta plinifikacije v regiji.

(Ključne besede: gospodinjstva, poraba energije, analize porabe, strukture porabe)

In this paper we analyse household energy consumption as part of a regional energy plan. The research has been performed in the area of the Primorsko-goranska County, Croatia. The analysis was based on a survey of households using a spatial division methodology. The region was divided into 14 zones based on geographic, climatic and economic characteristics as well as different population concentrations and urbanization. The analysis included a calculation of the total energy consumption for the whole region as well as for each zone. In addition, the total energy consumption has been analyzed in tems of energy sources and use of this energy for space heating, domestic hot-water preparation, cooking and non-thermal usage. Some additional parameters whhich relate to living standard and energy consumption, such as the number of household members and the number possession of household devices and cars have also been included. The results of the research are a basis for the project to intorduce gas to the region.

(Keywords: households, energy consumption, energy consumption analysis, consumption structures)

0 UVOD

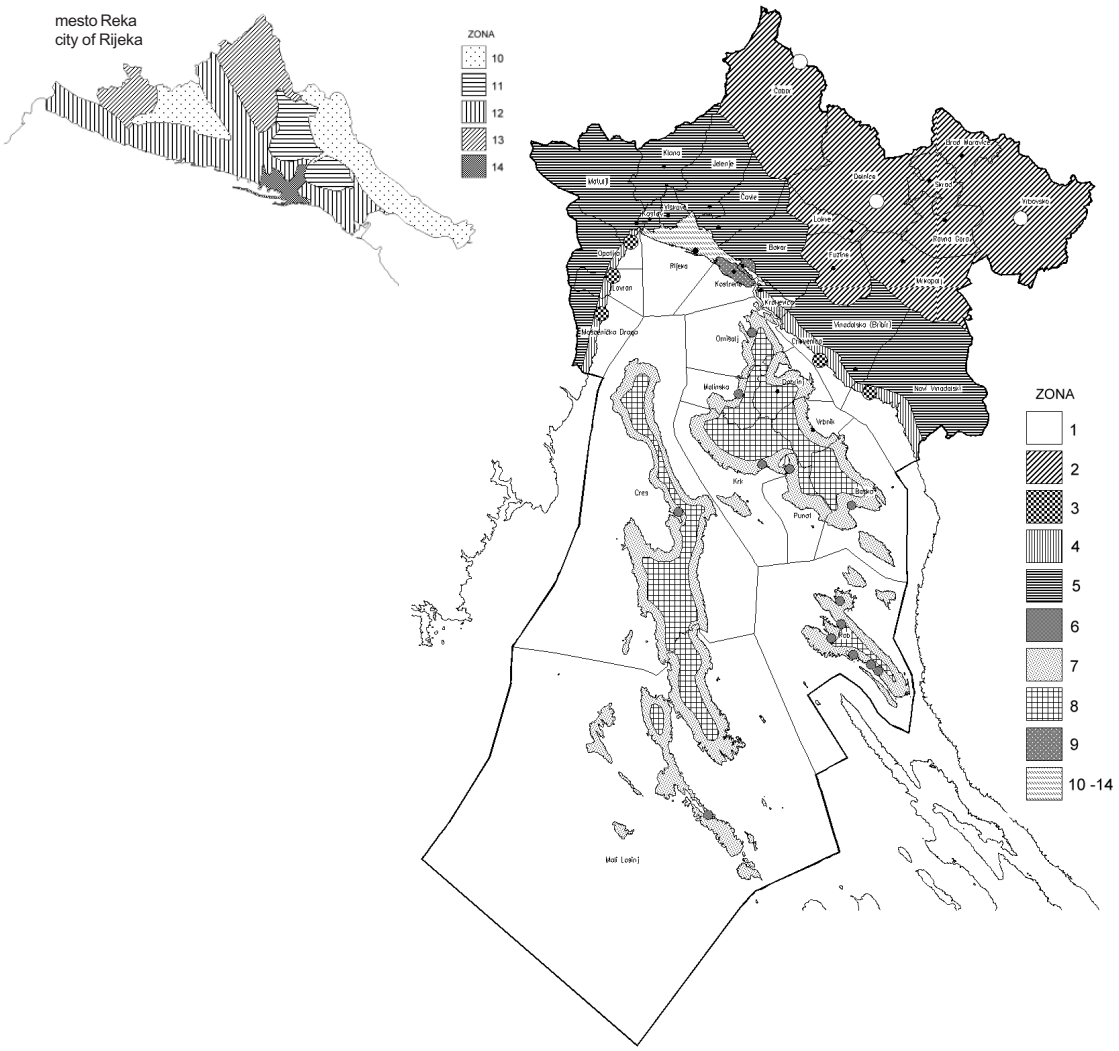
Projekt plinifikacije Primorsko-goranskega območja na Hrvaškem vključuje raziskavo in končne izračune energije v gospodinjstvih, industriji in javnih področjih. Ocena energijskih potreb je bila temelj za izračun končne porabe energije v gospodinjstvih. Predstavljeni vzorec je vključeval 2083 gospodinjstev, vsako od njih je sodelovalo z izpolnitvijo vprašalnika. Ta izbrani vzorec je vključeval 1,8% vseh gospodinjstev v Primorsko–goranskem okrožju in približno 2% prebivalstva. Za ta namen je bila regija razdeljena v 14 con, ki so bile določene glede na geografske, klimatske in ekonomske značilnosti, pa tudi glede na različno gostoto prebivalstva in urbanizacije. Število

0 INTRODUCTION

The project to introduce gas to the Primorsko-goranska County in Croatia includes research and calculations of the total energy requirements for households, industrial and public-service sectors of the County. A survey of the energy needs was the basis for a calculation of the total energy consumption of the households. Our survey encompassed 2083 households and every household was represented by a questionnaire. This representative sample comprises 1.8 % of the total number of households in Primorsko-goranska County and about 2% of the inhabitants. The region was divided into 14 zones based on geographic, climatic and economic characteristics as well as different population concentrations and urbanization. The number of surveyed households in a zone was calculated from

proučevanih gospodinjstev v coni je bilo določeno glede na odstotek števila prebivalcev, razen v tistih conah, kjer je poseljenost majhna. Tam je bilo vključenih petdeset gospodinjstev. Območje mestne občine Reke je bilo razdeljeno v pet con. Ta delitev ni vezana na administrativne ovire, ampak je namenjena le natančnim izračunom in predstavitvam potreb po energiji. Cone so prikazane na sliki in v preglednici 1.

the percentage of the number of inhabitants, except for those zones with a small number of inhabitants, where a minimum required sample of 50 households was adopted. The area of the Municipality of Rijeka was divided into five zones. These area divisions have no connection with administrative boundaries, but serve mainly for detailed and more accurate calculations and presentations of the energy requirements. The zones are shown in figure 1 and table 1.



Sl. 1. *Razporeditev con na Primorsko-goranskem območju*
Fig. 1. *Survey zones in the territory of Primorsko-goranska County*

1 REZULTATI ANALIZE

1.1 Splošna analiza

Število članov v gospodinjstvih je parameter, ki bistveno vpliva na porabo energije. Povprečno število članov gospodinjstev v Primorsko-goranskem okrožju je bilo 3,28. Slika 2 prikazuje povprečno število članov gospodinjstev v posameznih conah, slika 3 pa prikazuje porazdelitev gospodinjstev z različnim številom članov.

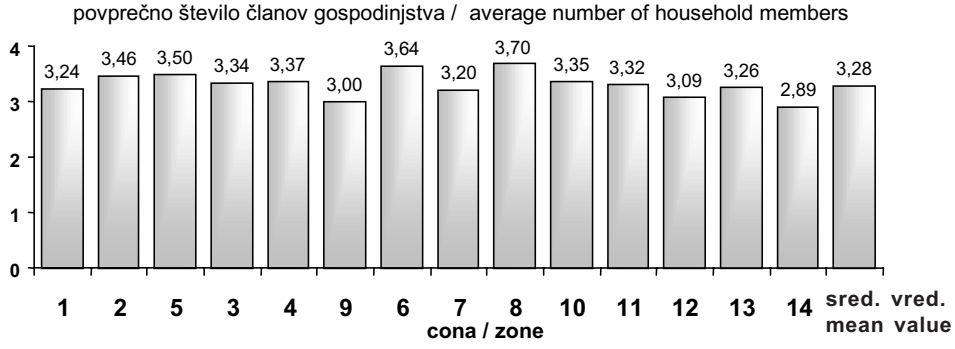
1 RESULT OF ANALYSIS

1.1 General analysis

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

Preglednica 1. *Seznam con*
Table 1. *List of survey zones*

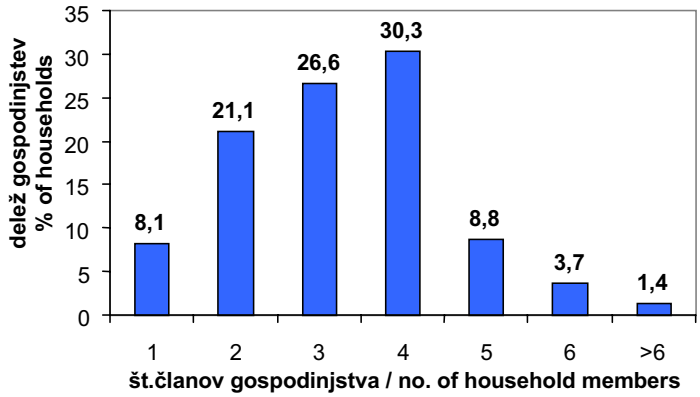
Cona Zone	opis description	št. prebivalcev no. of inhabitians	vključena gospodinjstva surveyed households
1	mestna središča Gorskega Kotarja urban centers of Gorski Kotar	7340	50
2	Gorski Kotar brez mestnih središč Gorski Kotar without urban centers	23205	142
3	turistična središča ob obali tourist centers on the coast	26524	166
4	obala brez turističnih središč coast without tourist centers	8483	53
5	obalno zaledje coastal hinterland	50524	313
6	turistične namestitve na obalah otokov tourist settlements on the coastal region of the islands	27716	173
7	druge namestitve na obalah otokov other settlements on the coastal region of the islands	4533	50
8	namestitve v zaledju otokov settlements in the hinterland of the islands	5154	50
9	Kostrena in Bakar Kostrena and Bakar	5576	50
10	Reka – pretežno družinske hiše brez plinovoda Rijeka – predominantly family houses without gas-pipe network	15176	94
11	Reka – pretežno družinske hiše s plinovodom Rijeka – predominantly family houses with gas-pipe network	4660	50
12	Reka – pretežno stanovanja brez plinovoda Rijeka – predominantly flats without gas-pipe network	114520	707
13	Reka – pretežno stanovanja s plinovodom Rijeka – predominantly flats with gas-pipe network	14490	90
14	Reka – stari del mesta s plinovodom Rijeka – older center with gas-pipe network	15229	95
	SKUPAJ ZA OBMOČJE TOTAL FOR COUNTY	323130	2083



Sl. 2. *Povprečno število članov gospodinjstev*
Fig. 2. *Average number of household members*

Uporaba različnih gospodinjskih naprav močno vpliva na energijsko porabo. Na sliki 4 je prikazana porazdelitev gospodinjskih naprav in lastništvo avtomobilov. Iz tega lahko vidimo, da ima 60 % gospodinjstev po en avtomobil, skoraj 13% gospodinjstev v okrožju pa dva ali več. Delež telefonskih priključkov znaša 93,5%, klimatske naprave pa uporablja le 1,8% gospodinjstev.

The use of different household devices strongly influences the household energy consumption. A breakdown of the use of household devices in the surveyed sample of households as well as the 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 have two or more cars. The number of household telephoneline-line connections is high, 93.5%; in contrast, air-conditioning devices are used in only 1.8 % of households.



Sl. 3. *Porazdelitev gospodinjstev glede na različno število članov gospodinjstev*
Fig. 3. *Number of members per households*

1.2 Analiza porabe energije

1.2.1 Celotna letna poraba končne energije v gospodinjstvih

Celotna letna poraba končne energije v gospodinjstvih v Primorsko-goranskem okrožju je približno 5,4 PJ. Celotna poraba končne energije po skupinah con je prikazana na sliki 5. Na isti sliki je prikazana tudi poraba končne energije glede na energijske vire. Lahko vidimo, da v območju Gorskega Kotarja in obalnega zaledja (cone 1, 2, 5) 61% celotne končne energije pridobijo z uporabo drv. V obalnih regijah pade ta odstotek na 38% na obali (cone 3, 4, 9) in na 27% na otokih (cone 6, 7, 8). V mestni občini Reka je glavni energijski vir elektrika (44%), sledijo drva (28%) in daljinsko ogrevanje (12%).

1.2.2 Poraba končne energije za ogrevanje

Na celotnem območju, z izjemo otokov, so glavni energijski vir ogrevanja drva, še posebno na območju Gorskege Kotarja in obalnega zaledja (cone 1, 2, 5), kjer znaša ta delež 75%, v obalnih regijah (cone 3, 4, 9) 61% in na otokih (cone 3, 4, 9) 44%. V mestni občini Reka znaša delež drv za ogrevanje 45%, sledijo elektrika (18%) in daljinsko ogrevanje (17%).

1.2.3 Poraba končne energije za pripravo tople sanitarne vode (TSV)

Največji delež porabe končne energije za pripravo tople sanitarne vode v gospodinjstvih zavzema elektrika, še posebej v obalnih regijah (cone 3, 4, 9), kjer znaša ta vrednost 91%, na otokih (cone 5, 6 in 8) 71%. V območju mestne občine Reka (cone 10-14) je delež električne energije nižji in znaša 67%, saj daljinsko ogrevanje zagotavlja

1.2. Analysis of energy consumption

1.2.1. Total annual energy consumption in households

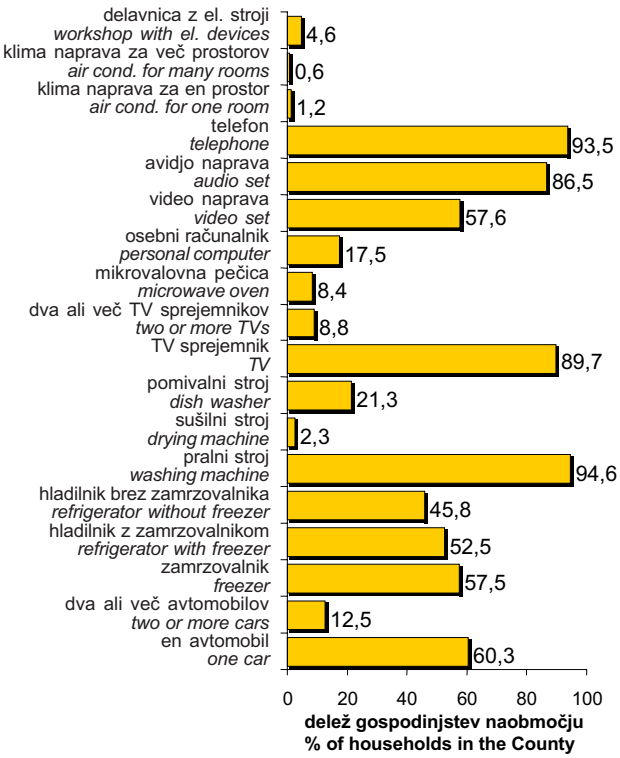
The total annual energy consumption of households in Primorsko-goranska County is about 5.4 PJ. The total energy consumption for every group of zones is shown in Figure 5. In addition, the total energy consumption in terms of energy sources has also been presented in the same figure. It can be seen that in the area of Gorski Kotar and the littoral hinterland (zones 1,2 and 5) 61% of the total energy is provided by wood fuel. In coastal regions the amount of wood fuel in the total energy consumption drops to 38% on the coast (zones 3,4 and 9) and 27% of the total energy consumption on the islands (zones 6, 7 and 8). In the Municipality of Rijeka electrical energy accounts for 44% of the total with wood fuel (28%) and district heating (12%) providing lesser amounts.

1.2.2. Final energy consumption for space heating

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

1.2.3. Total energy consumption for sanitary hot water (SHW) heating

The largest part of the totall 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 the total energy consumption for SHW heating is 91%. On the islands (zones 5, 6, 8) electricity provides 71% of the total energy for SHW preparation. In the Municipal-



Sl. 4. *Uporaba različnih gospodinjskih naprav in lastništvo avtomobilov*
Fig. 4. *Use of different household devices and car ownership*

17% energije. Največje deleže v porabi končne energije za pripravo tople sanitarne vode v regijah Gorskega Kotarja in obalnega zaledja (cone 1, 2 in 5) zavzemajo drva (53%) in električna energija (39%).

1.2.4 Poraba končne energije za kuhanje

Največji delež porabe končne energije za kuhanje v gospodinjstvih v obalnih regijah (cone 3, 4 in 9) in na otokih (cone 6, 7, 8) pomeni utekočinjeni naftni plin (UNP). V gospodinjstvih Gorskega Kotarja in obalnega zaledja pa imajo glavno vlogo drva (58%). V mestni občini Reka pa zavzema električna energija 37%, drva 27%, UNP 20% ter plin iz plinovoda 16%.

1.2.5 Struktura porabe končne energije

Največji del celotne porabe končne energije pridobijo iz drv (40%) in električne energije (35%). Sledijo kurilno olje 15%, daljinsko ogrevanje 5%, UNP 4% in plin iz omrežja 1,5%. Struktura porabe končne energije v gospodinjstvih glede na energijske vire in uporabo je prikazana na sliki 6.

Največji delež porabe končne energije v gospodinjstvih pomeni ogrevanje (59%), približno 13% priprava tople sanitarne vode, 11% kuhanje in 17% preostalo.

ity of Rijeka (zones 10-14) this proportion is lower and corresponds to 67%, while district heating provides 17% of the energy. Energy for SHW heating in the regions of Gorski Kotar and the littoral hinterland (zones 1,2,5) is provided by wood fuel (53%) and electricity (39%).

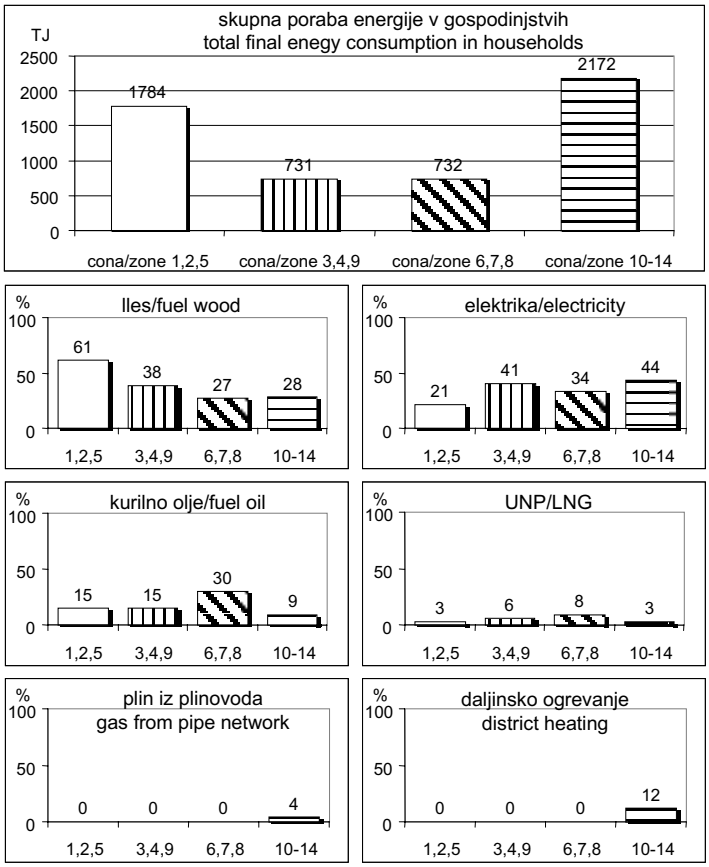
1.2.4. Total energy consumption for cooking in households

The largest proportion of energy for cooking in households situated in the coastal regions (zones 3,4,9) and on the islands (zones 6, 7, 8) comes form Liquified Naphta Gas (LNG). In households located in Gorski Kotar and the coastal hinterland, 58% of the energy for cooking is provided by wood fuel. In the Municipality of Rijeka the energy requirements for cooking are electricity (37%), wood fuel (27%), LNG (20%) and gas from a piped network (16%).

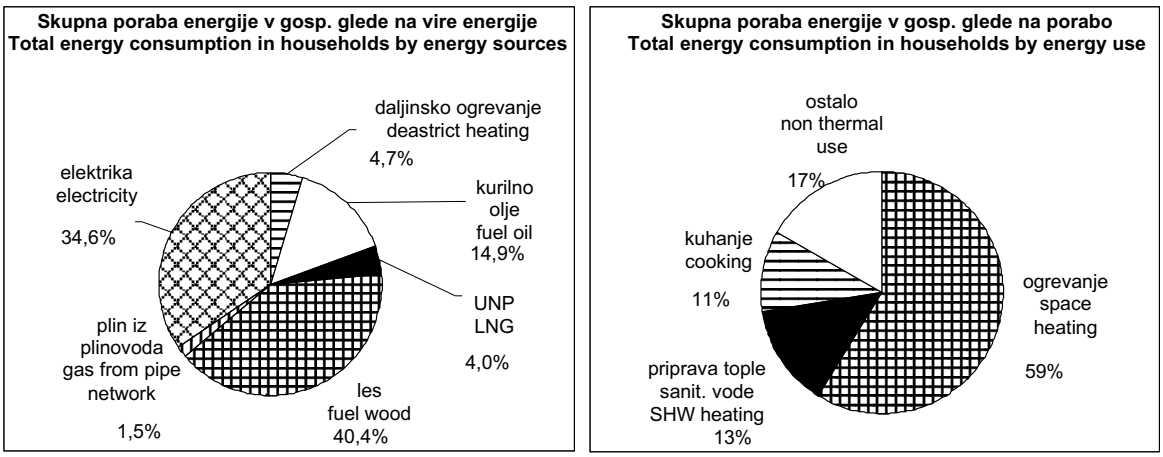
1.2.5. Energy consumption structure

The overall energy consumed in Primorsko-goranska County comes from wood fuel (40%) and electricity (35%). Additional energy is supplied by fuel oil with a proportion of about 15%, district heating 5%, LNG 4% and a piped-gas network with 1.5%. A breakdown of the total energy consumption for households in terms of energy sources and energy use is shown in figure 6.

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



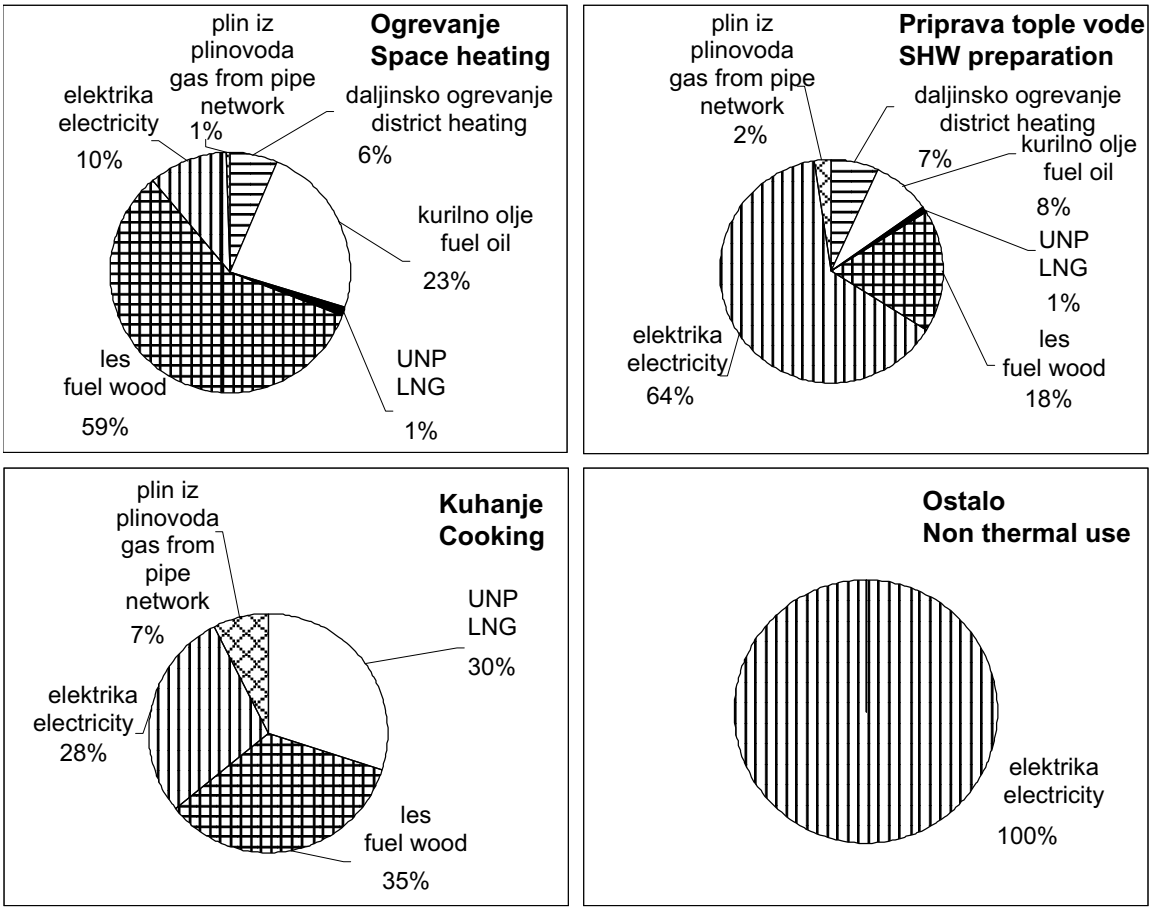
Sl. 5. *Celotna poraba končne energije v gospodinjstvih glede na različne energijske vire*
Fig. 5. *Total energy consumption in households in terms of different energy sources*



Sl. 6. *Porazdelitev porabe končne energije glede na energijske vire in glede na uporabo energije*
Fig. 6. *Breakdown of the total energy consumption in households by energy sources and by energy use*

Na sliki 7 je prikazana porazdelitev energijskih virov za vsako zgoraj omenjeno področje. Vidimo, da so drva glavni energijski vir za ogrevanje, temu sledita kurilno olje in elektrika. Za pripravo tople sanitarne vode izstopajo električna energija in drva. Kot energijski vir za kuhanje uporabljajo drva, UNP, električno energijo in plin iz omrežja.

The structure of energy sources for each segment of energy use is shown in figure 7. It is clear that wood fuel represents a major energy source for space heating in households, this is followed by fuel oil and electricity. The energy for SHW preparation is mainly provided by electricity and wood fuel. Wood fuel, LNG, electricity and piped gas are used as the main energy sources for household cooking.



Sl. 7. *Porazdelitev energijskih virov glede na uporabo energije*
Fig. 7. *Structure of energy sources for each segment of energy use*

2 SKLEP

Porazdelitev porabe končne energije v gospodinjstvih Primorsko-goranskega območja kaže, da je samo 80 TJ ali 1,5% energije porabljene iz plinovoda. Podobna analiza za območje mestne občine Reka kaže, da ta energijski vir pokriva le 3,7% celotnih potreb po končni energiji gospodinjstev. Rezultati analiz porabe končne energije gospodinjstev in izračuni porab energije v industriji in javnih sektorjih so osnova za predvidevanja potreb po energiji v okrožju. Na podlagi načrtovanj potreb po energiji in ocenitvi stroškov za izvedbo projekta lahko določimo območja, primerna za izvedbo plinifikacije. Rezultati raziskav so temelj za projekt plinifikacije regije.

2 CONCLUSION

The structure of energy consumption for households situated in the region of Primorsko-goranska County shows that only 80 TJ or about 1.5% of energy is provided from a piped-gas network. A similar analysis for the area of the Municipality of Rijeka shows that this energy source provides only 3.7% of the total energy needs of households. The results of the household energy consumption analysis and the calculation of energy consumption in industry and service sectors are the basis for a prediction of the energy requirements of the County. Areas where a new piped-gas network will be worthwhile can be determined from energy-demand predictions and the estimated capital cost for a piped-gas network using a feasibility analysis. The results of the research are a basis for the project to introduce gas to the region.

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